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Composite Steel Passenger Equipment

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A DESIGN FOR STEEL PASSENGER CARS HAS BEEN DEVELOPED AND LARGELY STANDARDIZED BY THE AMERICAN CAR & FOUNDRY CO. WHICH INCORPORATES A VERY STIFF AND STRONG BOX GIRDER CONSTRUCTION IN THE SIDES BELOW THE BELT RAIL, THAT IS EMPLOYED FOR CARRYING THE FULL WEIGHT OF THE CAR, INCLUDING THE CENTER SILLS AND LIVE LOAD. THE CENTER SILLS ARE DESIGNED FOR PULLING AND BUFFING STRENGTH ONLY. THE VESTIBULE HOOD INCORPORATES A MALLEABLE IRON PANEL OF PARTICULAR INTEREST.

Among the designs for steel passenger cars brought out during the past two years the one developed by the American Car & Foundry Co., from which several hundred cars of various classes have been built, presents a number of points of particular interest. This design is for cars wherein the framing and exterior sheathing throughout are of steel and the interior finishing from the sash rest up is of wood, the latter, however, not being used in any connection for strength or stiffness.

In general the design follows the principles that were adopted by this company for steel passenger cars with the first examples built, viz., that the sides of the car from the belt rail to the side sill should be formed into a plate girder or truss, which would not only be self-supporting but also capable of carrying the entire load, consisting of the weight of the underframing, the superstructure and the live load. The center sills to be continuous from end to end of the car and of a size suitable for resisting the pulling and buffing stresses only, and not only are not depended upon for carrying vertical loads, but are so supported that their own weight is carried on the sides. Many designers consider that if a size of center sills sufficient for carrying the buffing strain is used, and particularly if the center line of draft is centered below the neutral axis of the sill, the center sill itself is then capable of supporting its share of the load. This would not appear to be correct because of the deflections; the lighter beam deflecting of its own weight more than the whole structure as embodied in the finished car.

Throughout the design has been very carefully studied to cheapen the manufacture, as far as possible, and to facilitate any repairs which, through accident, may be required. The arrangement is such that practically any part of the underframe can be removed without any extensive dismantling or difficulty.

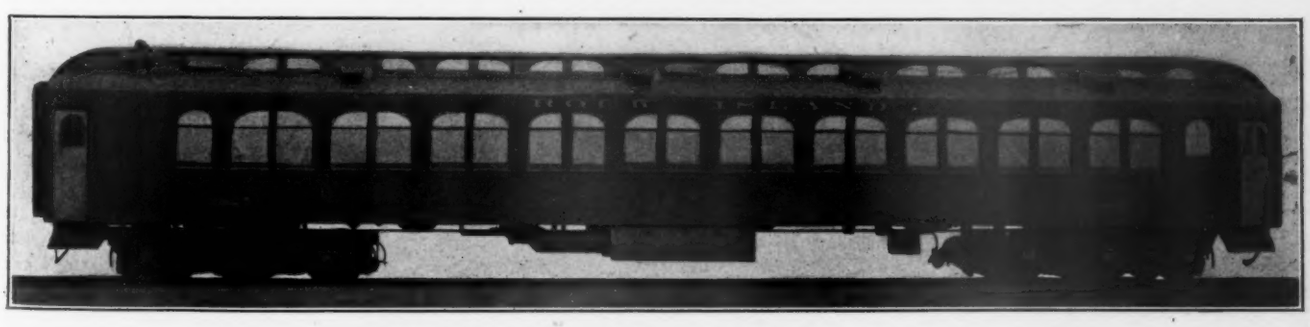
Another very interesting feature of the design is found in the construction of the vestibule, wherein malleable iron hood deck panels are employed, which carry with perfect rigidity practically the entire weight of the vestibule and its parts. This construction will be discussed in detail later.

This type of design has been used successfully by the American Car & Foundry Co. on many classes of cars, including coaches, baggage, chair, combination cars, postal and diners.

Underframe.

The underframe includes two 10 in. 35 lb. I-beams, set at 16 in. centers, extending continuous between the extreme ends of the car, for carrying the pulling and buffing stresses, the draft gears being mounted between them. These center sills measure 77 ft. in length over all and are carried through and secured to the bolsters, as is shown in the illustration. The side sills are in reality the whole side structure below the windows of which the part usually termed side sills are made up of the tension members of the double side truss, the outside one being a 6 x 6 x 5/8 in. angle and the inner one, which is located on top of the bolster cross bearers, etc., and 6 3/16 in. inside of the outer sill, being a 5 x 3 x 5/8 in. angle. There are also intermediate or platform sills extending from the platform end sill to the inside section of the double body bolster. These are 8 in., 11¼ lb. channels.

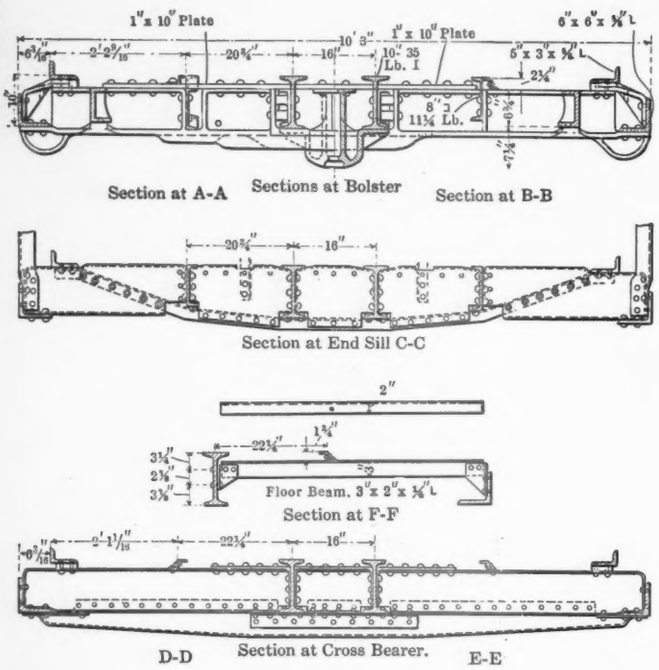
INTERIOR OF COMPOSITE STEEL PASSENGER COACH FOR THE ROCK ISLAND LINES.



SEVENTY-FOOT STEEL PASSENGER COACH FOR THE ROCK ISLAND LINES.

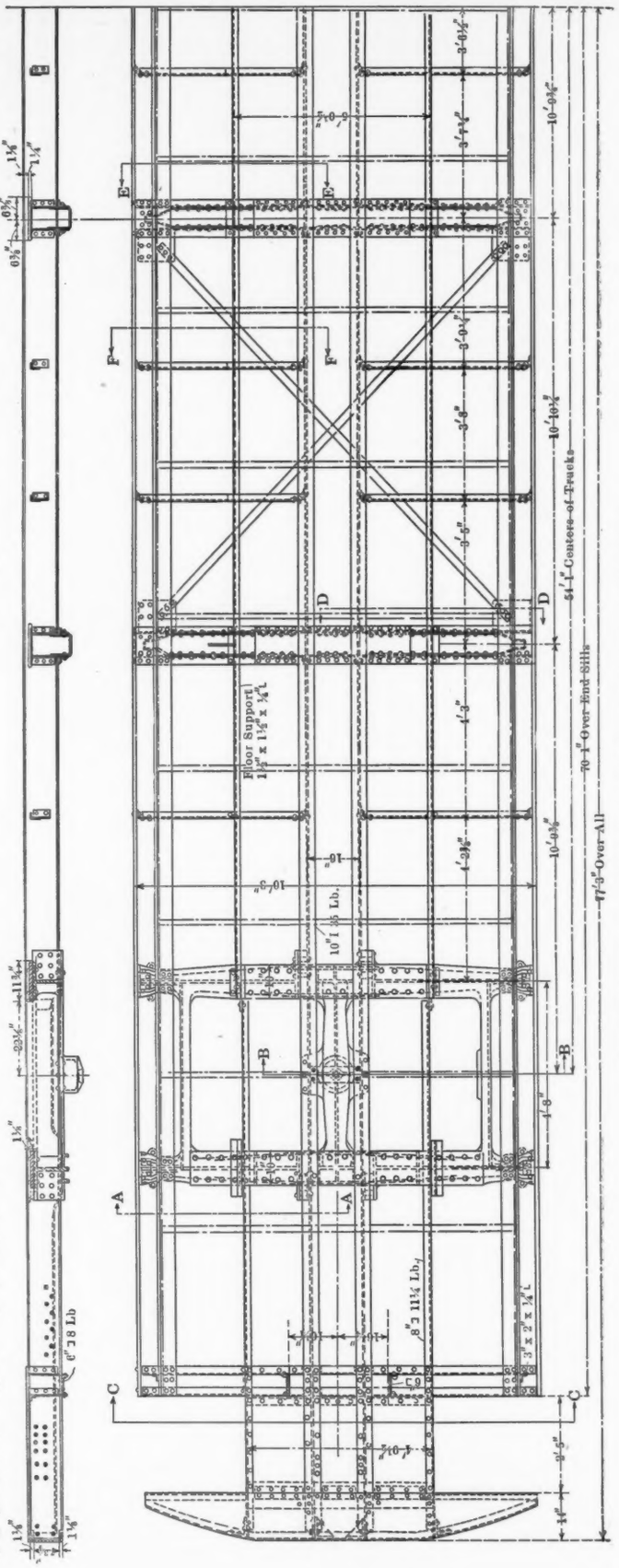
TRANSPORTATION LIBRARY

Between the double body bolsters, which are located with their centers 8 ft. inside of the end sill, there are four built up cross bearers for transferring the weight of the floor and load to the side girders. These cross bearers are located at practically equal distances, being about 10 ft. 10 in. apart. As will be seen by reference to the section at this point, they are built up in box girder form, the vertical members consisting of diaphragms pressed from ¼ in. plate into a dished section and secured between the side and center sills. The compression member is a ½ in. plate 11½ in. wide and 4 ft. in length, which is continuous, passing through openings cut in the webs of the center sills. The tension member of the cross bearers is a pressed steel shape made of ¼ in. plate, which passes below the center sills, and is securely fastened to the bottom of the side sill. The vertical sides of this member are continued up and are riveted to the diaphragm plates. Reinforcing angles, 3 x 2½ x ¼ in., stiffen it on each side directly below the center sills. This construction and arrangement is clearly shown in the cross section. It will be noticed that the cross bearers are very securely fastened to the exterior side truss and that it is very well designed for either center or end loading, as may be required by service.



Between the cross bearers there are two floor beams, placed at practically equal distances apart and composed of a 2 x 3 x ¼ in. angle fastened by knees to the center and side sills. These are intended to act entirely as a support for the longitudinal floor beams, composed of 1½ x 1½ x ¼ in. angles extending continuous between the bolsters and equally spaced between the center and side sills.

At the end sill a box girder construction somewhat similar to the cross beams has been employed, the design, however, being entirely for center loading and arranged to transfer the load including the overhang of the center and intermediate sills, together with the end framing and part of the vestibule to the side girders. This has been done largely by means of a truss extending continuous below the center and intermediate sills and secured to their bottom flanges, carried upwards and fastened to the tension member of the inner side truss. This is formed of a 6 in., 8 lb. channel shaped and arranged as is shown in the section at this point. One-quarter inch diaphragm plates, of suitable shape, act as stiffeners between the sills and together with the floor plates make up the box girder construction. Double cast steel body bolsters of a specially light design are employed. The casting is arranged to permit the center and intermediate sills to pass continuous through the bolster, the latter, however, going through but one arm. The bolster is arranged so that either it or the sills can be removed with no great difficulty.


Floor Support 1½" x 1½" x ¼" L
10' I 35 Lb.
8" 11¼ Lb.
6" 38 Lb
3" x 2" x ¼" L
54'-1" Centers of Trucks
70'-1" Over End Sills
UNDERFRAMING FOR COMPOSITE STEEL PASSENGER EQUIPMENT.

This construction is designed to use rolled steel tension members or cover plates, the one on the outside arm of the bolster being a 1 x 10 in. plate, 7 ft. 6 in. long, the inner one being a similar size plate 4 ft. 7½ in. long. It will be noticed that while the large side sill angle is fastened directly to the bolster casting the inner one is carried by a separate small casting, although also secured to the main bolster. This small casting acts as a stiffener and spacing block between the members of the double

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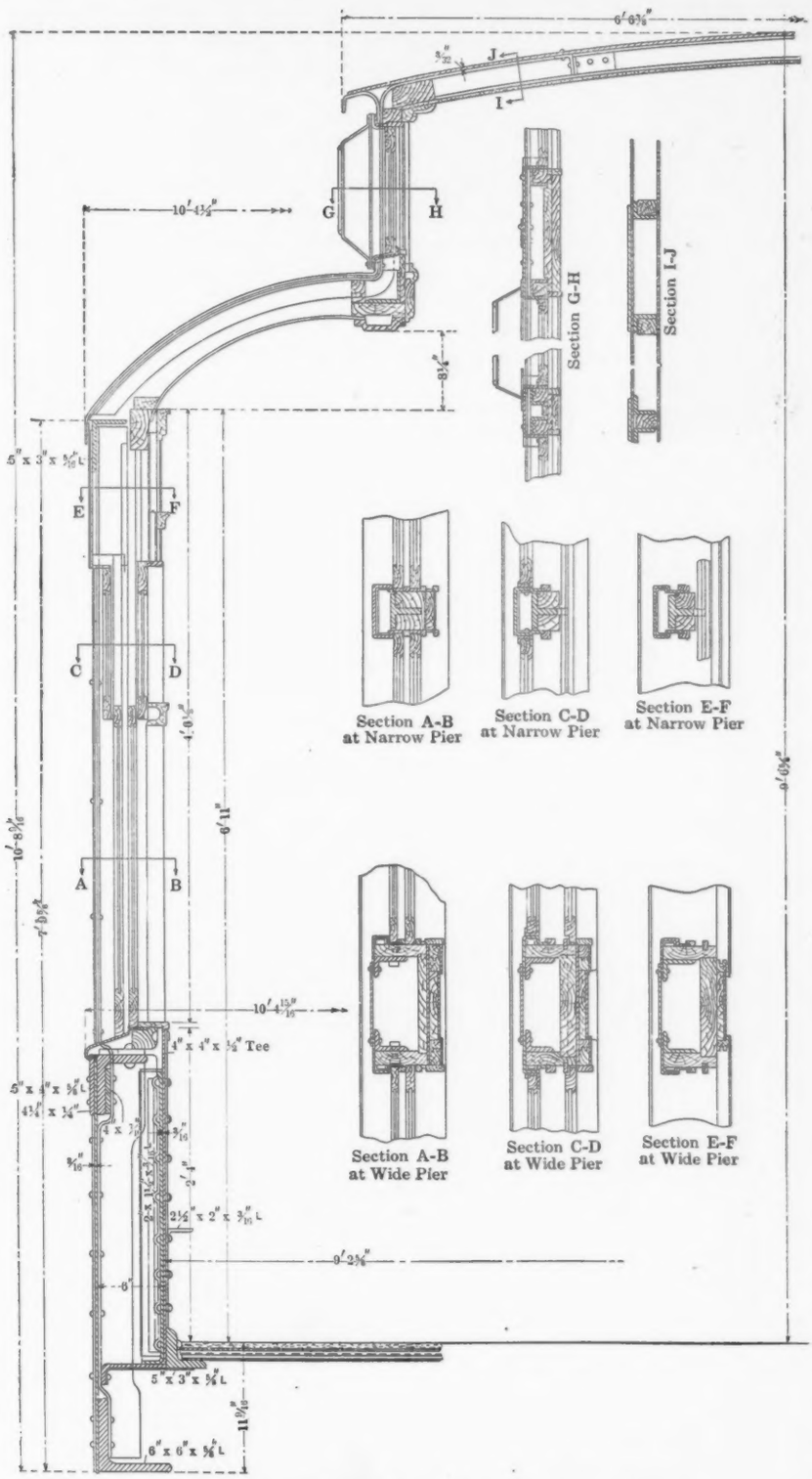
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Section A-B at Narrow Pier
Section C-D at Narrow Pier
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Section A-B at Wide Pier
Section C-D at Wide Pier
Section E-F at Wide Pier

SECTION SHOWING DETAILS OF SIDE AND ROOF FRAMING.

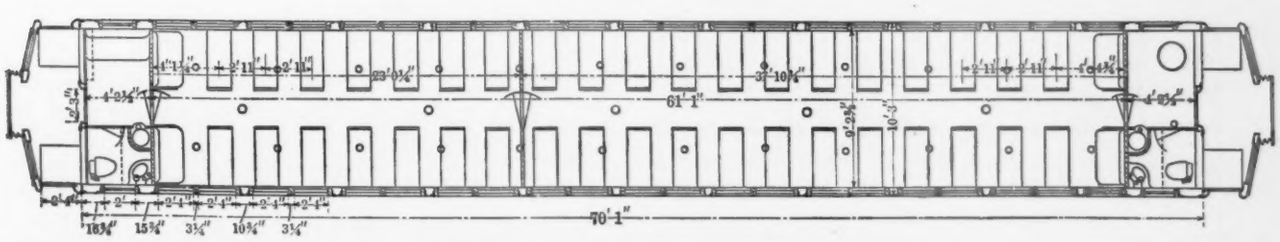
side truss at this point in the same manner as the diaphragm plates of the cross bearer and end sill also act.

The floor plates, of ¼ in. steel, are secured to the inner side sill, the floor supports, the center sills and to each other, the plates overlapping. In this manner these plates act as stiffeners of remarkable strength in the horizontal plane and hold the underframing in perfect alignment in this direction.

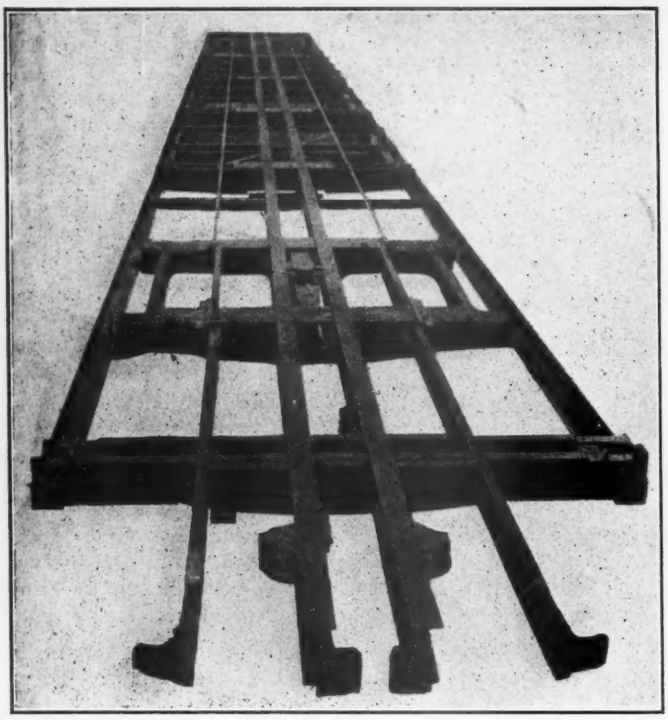
SIDE FRAMING.

As is mentioned above, one of the novelties of this design is the employment of a double side truss for load carrying which in effect produces practically a box girder giving considerable transverse stiffness as well as the vertical strength for load carrying. This is formed between the belt rail and the side sills, the outer truss, consisting of a 3/16 in. web plate, forming the sheathing of the car; the 6 x 6 x 5/8 in. side sill, which forms the tension member, and the 5 x 4 x 5/8 in. angle at the window sill, which forms the compression member. The latter is reinforced with a 4¼ x ¼ in. plate outside of the sheathing and a 4 x 7/16 in. vertical plate inside its vertical leg. The horizontal leg of this member is cut out to allow the side posts to pass through it. The side posts, which are continuous from the side sill to the plate, are formed of 3 x 2 x ¼ in. angles, and 3 x 3 in. tees and act as stiffeners to the web of this girder. The inside girder also has a 3/16 in. web plate, the 5 x 3 x 5/8 in. angle, as previously mentioned, for a tension member, and a 4 x 4 x ½ in. T for a compression member. The leg of this T is secured to the horizontal leg of the angle on the outside girder and secures the two girders together at that point. It is cut out to permit the side posts to pass through it. This girder is stiffened by 2 x 1½ x 3/16 in. L's set on an average of about 18 in. apart. At the ends these stiffeners are of 3 x 2 x ¼ in. angles continuing below the tension member and secured to the inner diaphragm of the end sill.

Above the belt rail, the side posts, which are depressed to pass around the large angle, as is shown in the illustration, continue to a 5 x 3 x 5/16 in. angle, which forms the plate. These posts are single or double, the former being 3 x 3 in. T's instead of angles, the spacing of course being arranged to suit the window opening. The latest construction of the A. C. & F. Co. does not carry the tees above the belt rail, instead the pinning is made of one piece and seated in pockets at belt rail and plate, thus saving considerable excess weight. To the steel posts are secured the wooden blocks for fastening the inside finish. The window frames are of pressed steel and are duplicates throughout the



PLAN OF ROCK ISLAND COACHES FOR USE IN THE SOUTH.



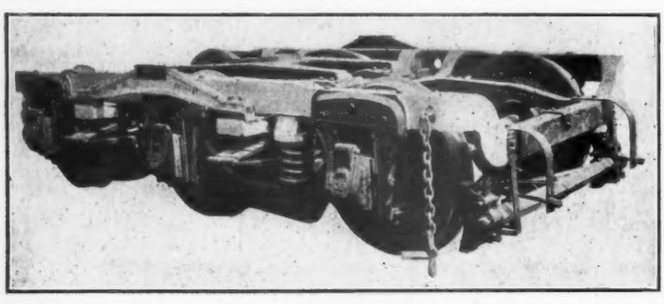
UNDERFRAME ASSEMBLED.

whole car; from inspection of the drawings it will be seen that these are so designed that they can be assembled complete on jigs before being applied to the car, thus insuring the interchangeability of the sash. The sash rest capping forming the bottom member of this construction is for this reason joined by welding in the center of each wide panel.

ROOF FRAMING.

Continuous carlines of 1¾ x 1¼ x 3/16. in. angles formed to the proper shape are secured to the top of the plates by malleable iron knees. They are spaced to bear the same relation to each other as to the side posts. The ones over the single posts being double, set back to back with 1⅜ in. spacing pieces between. The carlines are spaced and stiffened by the deck sill, a 3 x 3 x ¾ in. angle which runs continuous for the full length of the car, and by the eaves moulding, formed of a 3/16 in. plate bent into a U shape, which is also continuous for the full length of the car and connects to the malleable iron deck hood panel, which acts as a continuation of it for the vestibule. Near the center of the carlines are two rows of purlins formed of 1¼ x 1¼ x 3/16 in. angles cut to the proper length to fit and secured by angle iron knees. This construction is varied somewhat in one end panel, where there are two cripple carlines and the purlins are spaced somewhat further apart and the reinforcement is increased. On the opposite end the construction is the same as this except that continuous carlines are employed.

Plates 1/16 in. thick are riveted directly to the carlines and other parts and form the roof sheets. These plates are butt jointed and a cover plate is secured over each joint. The upper window frames are of pressed steel and are secured to the carlines and roof sheets in the same manner as are the side window frames. One of the illustrations shows the construction at this point in detail, as well as the wooden filling blocks for the attachment of the interior finish.



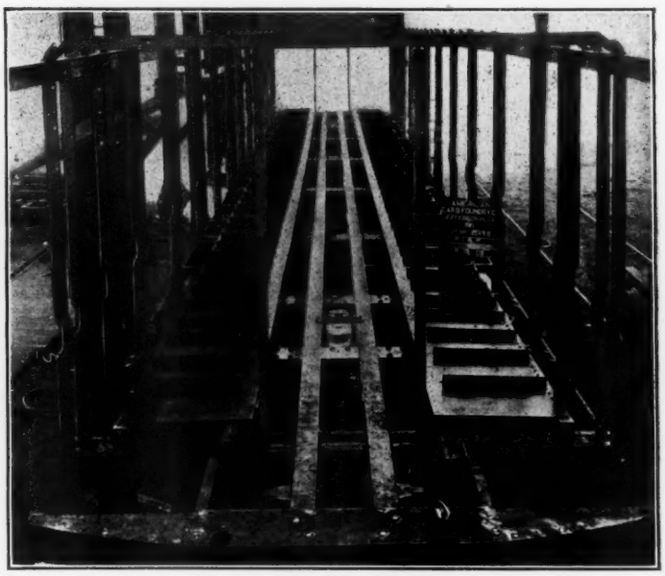
COMMONWEALTH CAST STEEL TRUCK.

BODY END FRAMING.

Two 6 in. channels form the door posts and continue below the floor level between the diaphragms of the end sill to which they are connected. At the top they are secured to a 3 x 5 in. angle, which is formed in bow shape and fastened to the side plates. Two small angles are secured between the corner and the door posts, and act as stiffeners for the ⅛ in. steel end sheathing.

VESTIBULE.

As mentioned above, one of the novelties of this design is found in the malleable iron deck hood panels, the details of which are shown in one of the illustrations. These are secured to the eaves moulding, to the deck sill, the end carlines and to the end plate, and are designed to give an absolutely watertight construction as well as a very strong rigid and light support to practically the whole vestibule framing. At the outer end they are riveted to the angle forming the vestibule end plate, which in turn carries the channels forming the center door posts of the vestibule and the angle and pressed steel frame forming the outer side posts. A 10 in. channel secured to the center sills and the intermediate sills forms the vestibule end sill. The angles forming the side plates of the car are of course continued to a connection with the plate of the vestibule. In addition the vestibule construction incorporates two 4 in. channels set with their web vertical and secured to between the body door posts and



GENERAL VIEW OF FRAMING. THE INNER SIDE GIRDER IS LYING FLAT ON THE UNDERFRAME.

the end construction of the vestibule. These act as supports for the vestibule diaphragm rigging.

The sheathing, frames, etc., on the vestibule are all of steel plate, in some cases wooden blocks being secured to the framing for the attachment of the light steel finish that it may be necessary to remove in case of repairs.

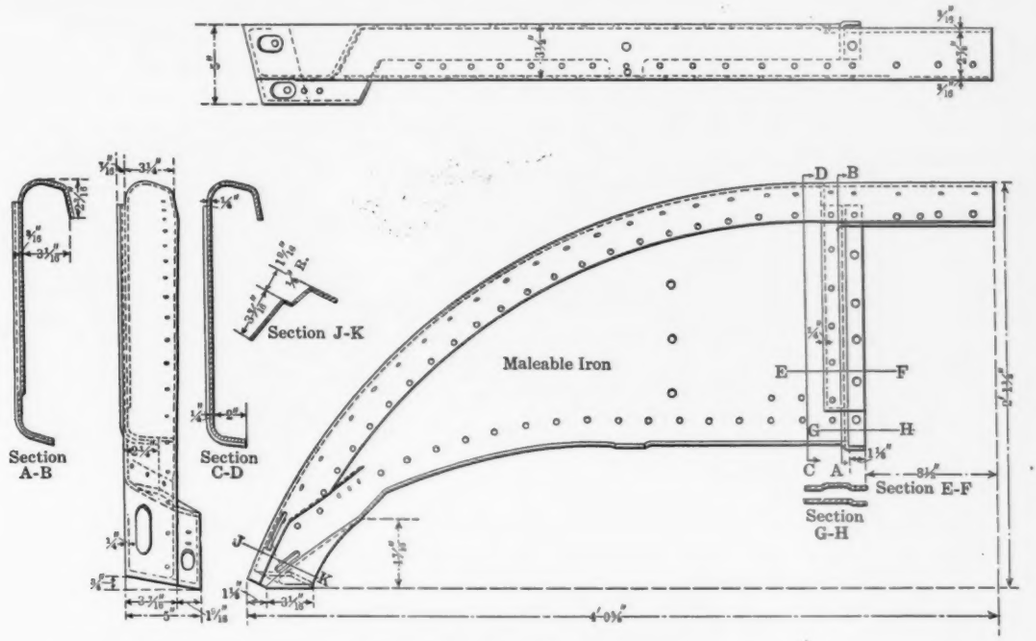
INTERIOR FINISH.

A polished mahogany veneer is used for the interior finish, this being mounted upon strips of wood bolted directly to the steel framing and arranged as is shown in the cross section. The veneer is built up with a fireproof varnish and is practically fireproof. The head lining is of agasote and the floor is of acandalith cement laid on a keystone galvanized iron flooring secured directly to the steel floor sheets.

One of the illustrations shows the interior appearance, well illustrating the artistic simplicity of the design. The cars are electric lighted, current being obtained from the axle lighting

system, the generator of which is driven by a four-ply, 5 in. belt. The arrangement of the lights, the particularly attractive fixtures for which were furnished by the Adams & Westlake Co., is such as to give an even diffusion throughout the whole car. There are five single center lights, 25 single light fixtures

Steel Trap Doors	National
Ventilators	Garland
Insulation in Side Girder	Ceilinite
Insulation in Side Girder	Linofelt
Heating Equipment	Chicago Car Heating
Wiring	Kerite



MALLEABLE IRON DECK HOOD PANEL.

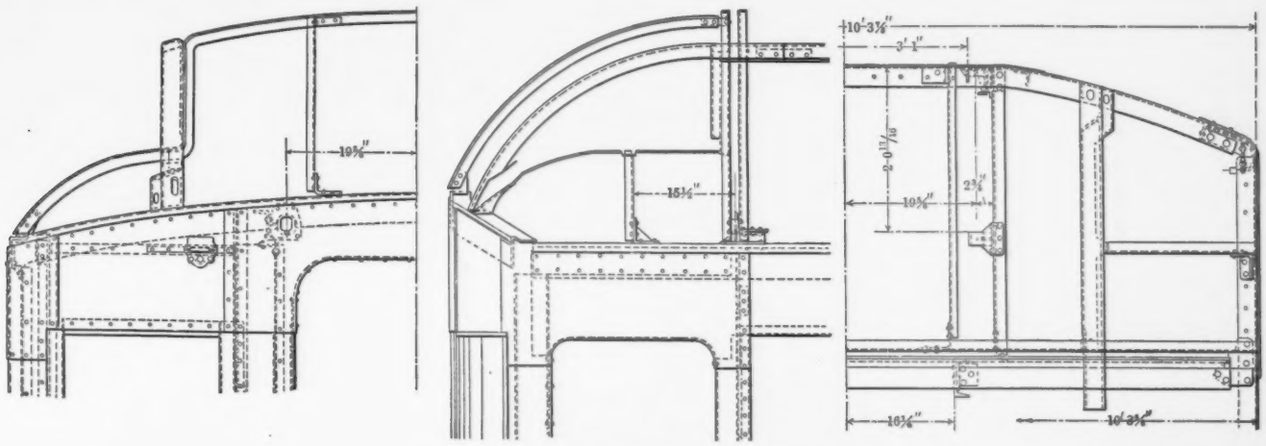
along the deck and five hall and vestibule lights. Willard storage batteries are used in connection with the lighting system. The basket racks are bronze and 5 ft. 1¾ in. in length, so located as to be practically continuous. The Starritt reversible seats with high backs are upholstered in olive plush and a strip of Wilton carpet of the same shade is placed in the aisle.

Cast steel 6-wheeled trucks of the Commonwealth Steel Company's design are used under these cars. The general features of construction are clearly shown in the illustration.

In addition to the specialties above mentioned others which were used on the Rock Island cars are given below:

Train Connectors	Gibbs
Wheels	Standard Steel Co.
Journal Boxes	McCord
Brake Beams	Waycott
Bolsters	Commonwealth
Axle Light	Safety Car Heating and Lighting Co.
Balata Belting	New York Leather Belting Co.

Many of the other interesting features of this design, including double carline at body end frame for easy removal of hood members in case of damage to the end, have been described in detail in articles we have published descriptive of cars built by this company for the New York Central Lines suburban service



VESTIBULE HOOD CONSTRUCTION.

Draft Gear	Waugh Draft Gear Co.
Platforms	Standard Steel Co.
Window Fixtures	Edwards
Window Fixtures, Universal	Grip Nut Co.
Deck Sash Ratchet	Hart
Deck Sash Ratchet	Universal
Glass in Deck Sash and Upper Side Windows	Pressed Prism Plate Glass Co.
Couplers	Janney
Centering Device	Chaffee
Curtains	Pantasote
Roller and Side Bearings	Wood
Air Brake Equipment	New York

(Mar., 1907, p. 81) and the Long Island Railroad Coach (Feb., 1907, p. 41).

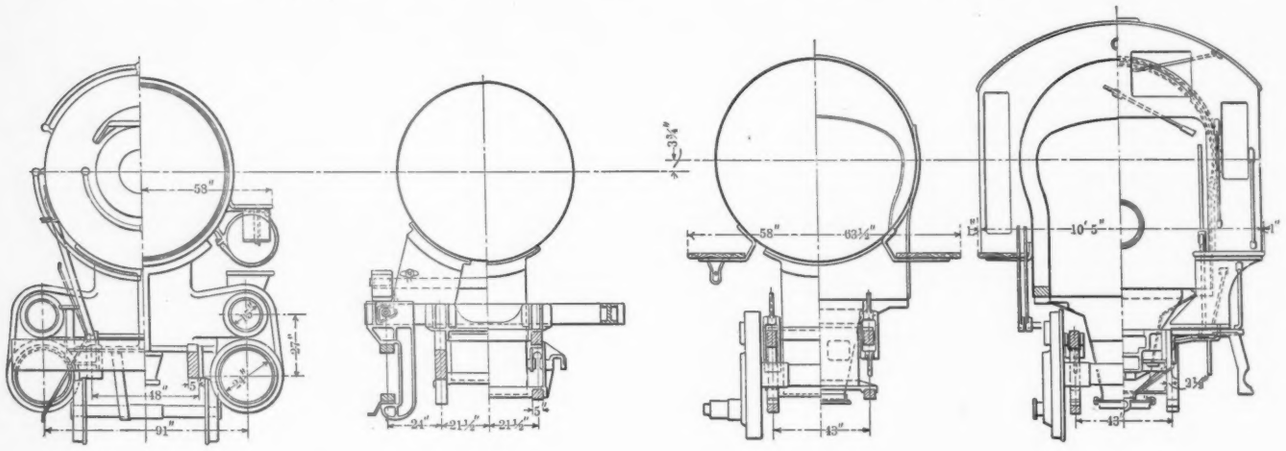
A FLUX FOR USE IN BRAZING CAST IRON can be made by mixing 1 lb. of boric acid, 4 oz. of pulverized chlorate of potash, and 3 oz. of carbonate of iron. To make a good brazed joint, the metal should be carefully cleaned and the pieces heated to a bright red before applying the flux.

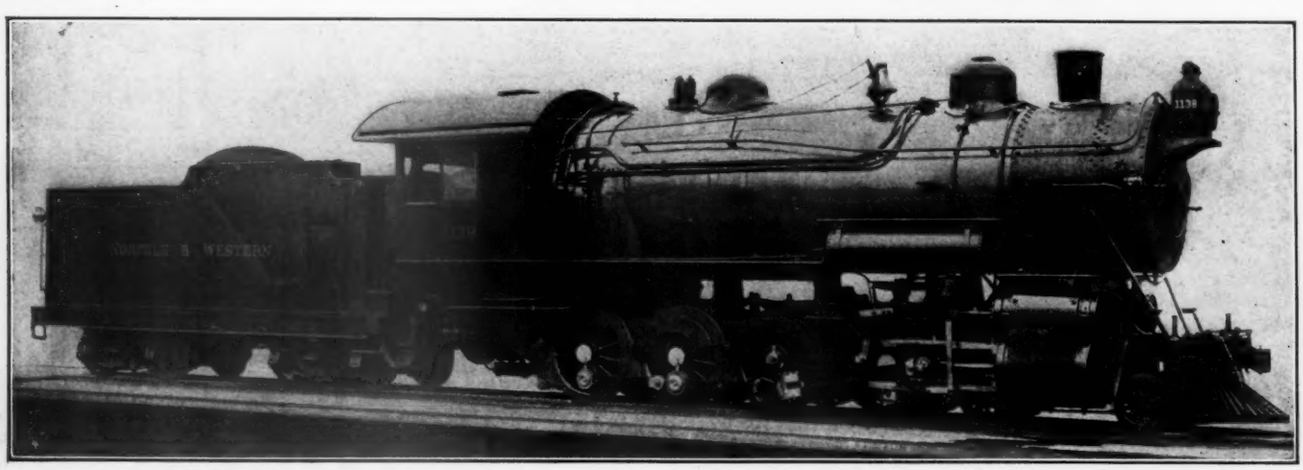
4-8-0 Type Locomotives for the Norfolk & Western Railway

AFTER FOUR YEARS' EXPERIENCE WITH A LARGE NUMBER OF 4-8-0 TYPE LOCOMOTIVES BUILT BY THE BALDWIN LOCOMOTIVE WORKS, THE NORFOLK & WESTERN RAILWAY HAVE ORDERED FIFTY MORE OF THE SAME TYPE FROM THESE WORKS, THE NEW ONES, HOWEVER, BEING CONSIDERABLY MORE POWERFUL.

In 1906 and 1907 one hundred locomotives of the 12-wheeled type were put into service by the Norfolk and Western Railway and have been eminently successful in handling heavy freight traffic. These locomotives were very fully illustrated and described on page 443 of the November, 1907, issue of this journal. Recently, as a further addition to the motive power, the company purchased fifty more of the same type, which have since been put into service and are giving very successful results, as is indicated by the data obtained from recent tests, mentioned later.

As compared with the earlier order, known as Class M-1, the new locomotives, or Class M-2, have the same diameter driving wheels and the same steam pressure. They also have practically the same grate area. The cylinders, however, have been increased from 21 x 30 in. to 24 x 30 in., and the boiler has been

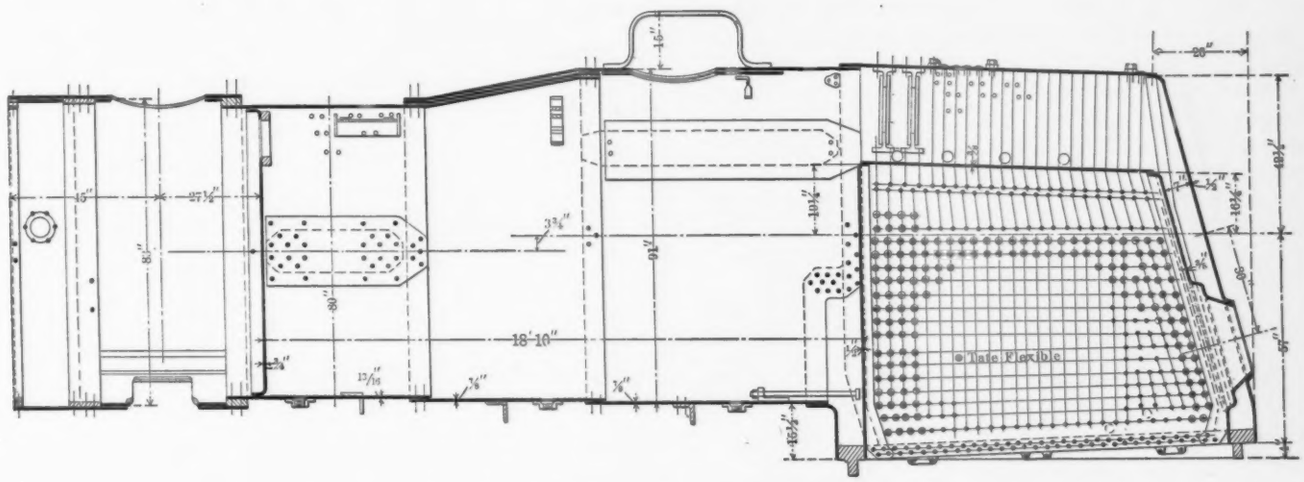




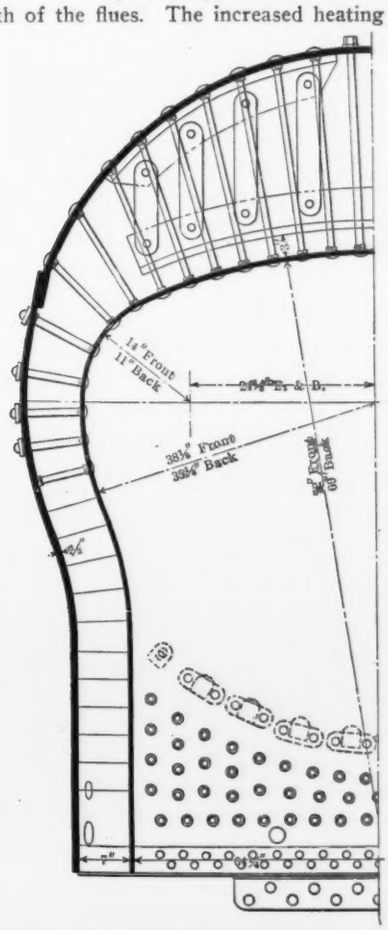
enlarged to be in practically the same ratio, with the exception of the grate area. The weight on drivers has been increased from 165,850 lbs. to 213,200 lbs., and the total weight by over 57,000 lbs. The theoretical tractive effort has jumped from 40,000 to 52,300 lbs.

This new design has been prepared by the motive power department of the railroad and was built under the inspection of the mechanical engineer, and, of course, is based on the service of the previous locomotives. A comparative study of the two designs will indicate that the increase in power desired has been obtained by a practically corresponding increase in the size of cylinders and of the boiler. The ratio of total heating surface to volume of cylinders only being increased from 230 to 260. The grate area was left practically the same as before, as were also the length of the flues. The increased heating surface has been obtained by a 10 in. increase in the diameter of the boiler and about a 60 per cent. increase in the number of flues. Of course the related features, such as diameter of piston valves, size of frame, and all other parts, have been redesigned to suit, but few changes have been found desirable in the general arrangement.

Possibly the most noticeable change of this kind is seen in the use of the single front rail under the cylinders and a cast steel deck plate instead of the double rail and usual bracing, which was used on the Class M-1. New types of pedestal binders are also introduced, the thimble design being replaced with the forged strap binders held in place by three 1¼ in. bolts at each end. The valve gear has also been changed to use outside longitudinal bearers, as is shown in the illustration. Other details that have been redesigned will be noticed in the shape of the cab, the location of the air drums, which are now underneath the running boards instead of between the frames, and in more substantial frame bracing. A change to the slabbed section rear frame with a heavy cast steel foot plate extending further back from the boiler head is also noticed.



VERY LARGE BOILER ON NEW NORFOLK AND WESTERN 4-8-0 TYPE LOCOMOTIVES.



SECTION OF FIREBOX.

It is in the boiler, however, that the point of greatest interest is found in this design and the novel features of this consists of a wide fire box, which has side water legs arranged on the ogee curve and 7 in. width of mud ring all around the fire box. The boiler is of the extended wagon top design, measures 80 in diameter in front and 91 in. at the dome course. A front flue sheet of unusual thickness, viz., ¾ in., is noticed; the dome is flanged from a single steel plate also ¾ in. thick. A ¾ in. liner is used for reinforcing the sextuple riveted longitudinal seams, these joints being welded at each end. The fire box is of the radial stay design with a vertical throat and sloping back head. The mud ring is cast steel. The fire door opening is 18 in. in diameter and formed by flanging both sheets outward and riveting them directly together, this construction being the same as was used on the earlier design. In this case, however, the unusual width of water space made it necessary to form the inside fire box sheet with a flat annular space, reducing the width of the water leg immediately around the door to 4 in.

Flexible stays to the number of 477 are found in the boiler, being used to stay the entire throat sheet, the outside rows on the back head and in the breakage zone of the side sheet, as is shown in the boiler elevation. The grate is of the rocking type with bars extending entirely across the box, being arranged to shake in two sections, front and rear.

The shape of the side water legs is necessitated by the use of a somewhat narrower grate than would customarily be employed in a boiler of this diameter. It will be remembered that a couple of years ago C. A. Seley advanced the theory that the ogee side sheet in a narrow fire box boiler was responsible to a large extent for the fewer fire box failures which occurred in

the earlier times. This theory seemed to be most reasonable and it would appear to be good practice, where possible, as it was in this case, to obtain the grate area desired without excessive length and still maintain the old shaped water leg. It will be noticed that the side and crown sheets are in one piece, although the outside wrapper sheet is in three sections. This same construction was used on the Class M-1, although there the water legs were vertical and not as wide.

TESTS.

Recently one of these locomotives, No. 1124, was put under test between Roanoke and Christiansburg, and the result on the grade forming the last 29.7 miles, is shown in the accompanying illustration, wherein the various readings taken are presented graphically. The train consisted of 16 cars, including the dynamometer car and caboose, and weighed behind the tender 1,046.9 tons. In addition there was 215 tons weight of engine and tender. The total running time was 2 hrs. and 15 min. This includes at least two stops. This section of this road between Elliston and Christiansburg is on a steady up grade averaging 1.32 per cent. The following data, however, is the average for the total run from Roanoke:

COAL CONSUMPTION.

Total lbs. (excluding delays)	13,000
Per sq. ft. grate per hour	128.4

WATER CONSUMPTION.

Total lbs. evaporated	73,100
Equivalent lbs. evaporated	88,889
Equivalent evaporation per lb. of coal	6.84
Equivalent evaporation per sq. ft. heating surface per hour (excluding delays)	8.87
Boiler efficiency, per cent	55.3

The draft in inches of water was 7.68 in the smoke box and 3.2 in the fire box. The temperature of the gases in the front end was 732.4 degs. back of the baffle plate and 663.1 degs. ahead of the baffle plate. The steam showed an average quality of 98.9 per cent.

It will be seen that between Elliston and Christiansburg the average draw bar pull was but 33.872 lbs. and the indicated horsepower was 1,157. The dynamometer horsepower was an average of 926, making 231 horsepower absorbed in pulling the locomotive and its tender up the grade and in overcoming internal engine resistance. Of course, this record is for less than half the total distance and it is not possible to make any investigations in connection with the coal and water consumption as compared with the draw bar pull from the data at hand. The boiler efficiency is very fair.

The general dimensions, weights and ratios of the Class M-2 locomotives are given in the following table:

GENERAL DATA.

Gauge	4 ft. 8½ in.
Service	Freight
Fuel	Bit. coal
Tractive effort	52,300 lbs.
Weight in working order	261,100 lbs.
Weight on drivers	213,200 lbs.
Weight on leading truck	47,900 lbs.
Weight of engine and tender in working order	430,000 lbs.
Wheel base, driving	16 ft.
Wheel base, total	27 ft. 1 in.
Wheel base, engine and tender	62 ft.

RATIOS.

Weight on drivers ÷ tractive effort	4.08
Total weight ÷ tractive effort	4.99
Tractive effort × diam. drivers ÷ heating surface	714.00
Total heating surface ÷ grate area	91.80
Firebox heating surface ÷ total heating surface, %	4.43
Weight on drivers ÷ total heating surface	51.80
Total weight ÷ total heating surface	63.50
Volume both cylinders, cu. ft.	15.80
Total heating surface ÷ vol. cylinders	260.00
Grate area ÷ vol. cylinders	2.83

CYLINDERS.

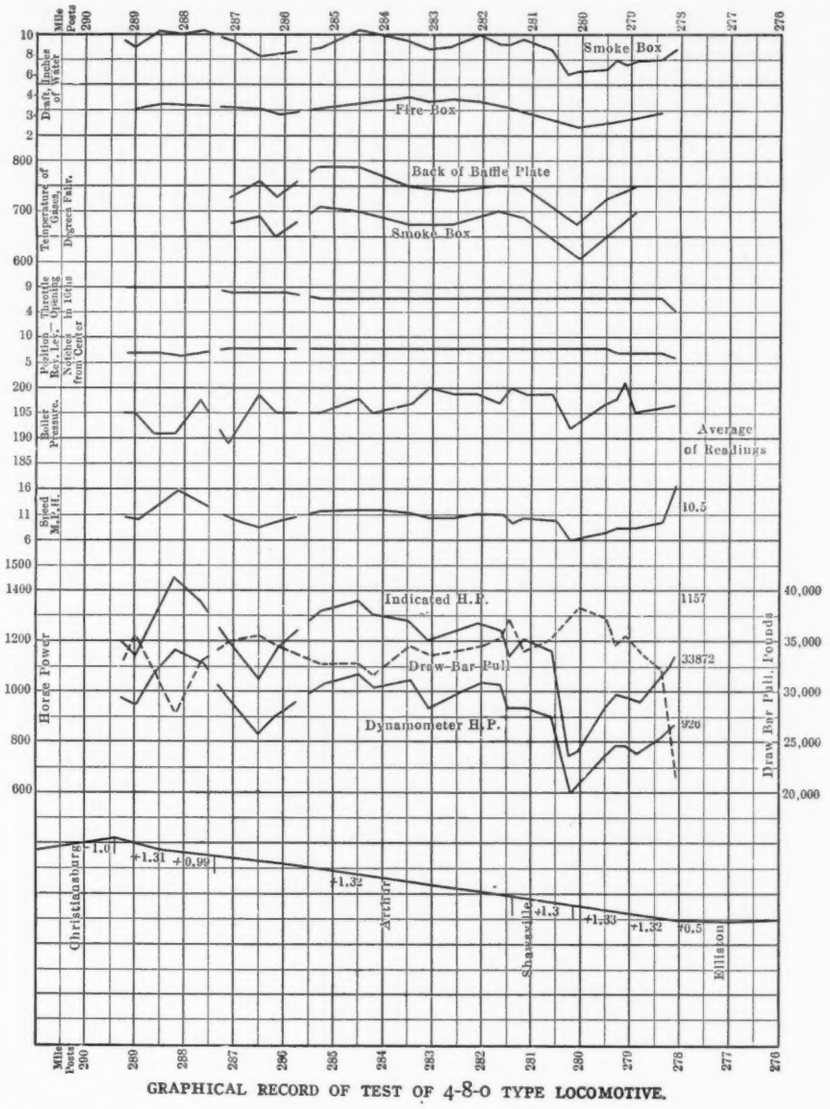
Kind	Simple
Diameter and stroke	24 x 30

VALVES.

Kind	Piston
Diameter	15 in.

WHEELS.

Driving, diameter over tires	56 in.
Driving, thickness of tires	3 in.
Driving journals, main, diameter and length	11 x 12 in.
Driving journals, others, diameter and length	10½ x 12 in.



GRAPHICAL RECORD OF TEST OF 4-8-0 TYPE LOCOMOTIVE.

Engine truck wheels, diameter	27 in.
Engine truck, journals	5½ x 10 in.

BOILER.

Style	Wagon top
Working pressure	200 lbs.
Outside diameter of first ring	80 in.
Firebox, length and width	100⅛ x 64¼ in.
Firebox plates, thickness	⅜ x ½ in.
Firebox, water space	7 in.
Tubes, number and outside diameter	386—2¼ in.
Tubes, length	18 ft. 10 in.
Tubes, material	Steel
Heating surface, tubes	3,922 sq. ft.
Heating surface, firebox	182 sq. ft.
Heating surface, total	4,104 sq. ft.
Grate area	44.7 sq. ft.

TENDER.

Wheels, diameter	33 in.
Journals, diameter and length	5½ x 10 in.
Water capacity	9,000 gals.
Coal capacity	14 tons

ANNUAL PASSES TO BE REDUCED.—Commencing January 1 next, the issuance of annual complimentary passes by Western railroads to representatives of other roads below the rank of either general assistant passenger agent or assistant general freight agent is to cease. This action has been made possible by the decision of executive officers of the railroads that freight departments be brought under the same restrictions in this respect as passenger departments.

EDUCATION AND THE DEVELOPMENT OF THE APPRENTICE*

Under the present educational system the conditions are indeed rare where the American boy receives any encouragement to enter the industries, either in the home or school. In most cases the parental influence is either absolutely wanting, or it is against any form of manual work; on the other hand, the teacher often lacks sympathy and is indifferent to a boy's pursuits, especially if he is not strong intellectually.

What we need are well planned industrial courses, in charge of broad-minded men who will awaken and develop the home influence and give increased value to the dignity of labor.

Following somewhat the recommendations of Dr. J. P. Haney (Director of Manual Training in New York), I would urge that manual training be taught in all the elementary schools, and that at the end of the 6th grade, corresponding to the age of 12 or 13 years, separate elective courses be established; the one, as at present arranged for professional and commercial training, as well as the higher technical training, leading to and through the high school; the other having in view the industrial training of the pupil. Bearing in mind the class of boys it is desired to interest and develop, and the object to be attained, practical work should predominate, but during the 7th and 8th grades, that is, the first two years, the training should be general, with a view to increasing the versatility of the boy rather than his specific training during these years. In order to keep the boy busy, inasmuch as there would be less preparation of studies, it would seem desirable to require that 6 or 7 hours a day be spent in the school, of which time at least one-half should be devoted to industrial work under skilled workmen; the rest of the time could be divided between such subjects as drawing and the study of industrial geography, history, English and arithmetic; this latter should contain plenty of practical problems of interest to the pupils. There should also be shop talks relating to the various industries.

Two additional years would follow this industrial-preparatory, and these should be trade-preparatory, in which the time spent is devoted to some one definite trade, to the end that by judicious and intelligent training the boy may enter some industry where he will be given an opportunity, at fair wages, under an apprentice instructor to finish the trade begun in the trade preparatory school. In this school, which a boy enters at 14 or 15 years of age, the time could well be increased to 8 hours a day, with 4 hours on Saturday, and there seems no good reason why the practical work should not be continued for eleven months of the year. The amount of time spent in practise would vary somewhat, but in general in most trades 4 hours a day could be devoted to shop work and the remaining 4 hours divided between drawing and other studies, more or less related to the specified trade. During the course history and civil government, English, arithmetic, practical geometry and physics should be given some attention. An important feature of this course would be the co-operation of an advisory committee suggested by Mr. Higgins. This would materially assist in co-ordinating the work of the school with that of the various industries, and it is not at all improbable that in many localities satisfactory arrangements could be made by which the more advanced pupils might, under proper instruction and suitable wage conditions, be employed on commercial work for local firms. This would greatly increase the interest and would furnish a stimulus for speedy work usually lacking in school shops.

The amount of time required to finish a trade would be reduced very materially under such a plan, and it is safe to say that the hopes of early reward would encourage many a boy to hold out and complete the entire school course instead of quitting as at present. It is not to be expected that all such boys would become skilled tradesmen; but it must be conceded that the training could well be adapted to prepare all boys who might desire to enter industrial pursuits and by a process of selection and elimination, those best qualified by natural endowment and otherwise, could be trained as all-around men for the trades, while others, who did not give such promise of development, would be trained for some special work, as for instance, machine molding, in the foundry or machine hand in other industries.

It is recognized that no universal system of trade education will be generally applicable to every community; local conditions will suggest and demand modifications; and we should expect in certain localities to find emphasis laid on the teaching of trades required in the industries which predominate in the vicinity.

In working out the course of study for such industrial education it should be constantly borne in mind that some of the boys who enter upon industrial training will reach a time in their lives when they will want to keep on with their studies and enter a technical college. Provision for such boys must be made by a modification of the high school courses with this in view, and if necessary, the college entrance requirements should be changed.

It is admitted that the expense in equipment and maintenance of such departments in our public school systems would be considerably greater than that now incurred, but it is submitted that the cost is a matter of lesser import than the results. Attractive industrial departments manned by enthusiastic, capable, properly paid teachers would cause a greater number of pupils to remain in the schools for a longer period, and the intellectual development, coupled with the training in discipline received by the additional thousands of school children all over the country would in itself be an economic advantage. Moreover, if the introduction of such departments would afford better preparation for the industries and reduce the idle or waste years of a boy, the productive gain and increase in wealth in a given community would more than warrant any reasonable additional cost.

On the other hand, the expense involved on account of "repeaters" would be greatly diminished and the amount thus saved would materially assist in maintaining industrial schools.

It is also submitted that the hopes and ambitions of a boy, the habits of industry, the definiteness of purpose in life, inspired by contact with real things: all make for a higher uplift which will result in the social betterment of the people and its attendant lessening of crime fostered by idleness.

* Conclusions of a paper by Prof. J. J. Flather read before the National Founders' Association.

THE PRICE OF RADIUM.—Sir William Ramsey stated recently that the cost of radium was now $2,100,000 per ounce, which is slightly less than a year ago, when, in an address at the laying of the cornerstone of the radium factory at Limehouse, he said that the value of the substance was $2,500,000 an ounce, which was at the rate of $90 per milligramme. In January last the price was said to be $3,000,000 an ounce. About a year ago there was only a quarter of a pound of radium in the whole world, and the quantity is not much greater at the present time; in fact, literally pure radium only dates from September 5 last, when Mme. Curie told the Academy of Sciences in Paris that she had at last succeeded in obtaining pure radium. For some time past a radium bank has existed in Paris, and last January one was established in London, and similar institutions are to be founded in other great cities. These banks loan the precious substance to scientists and physicians. The cost is enormous, as much as $200 being charged for the use of 100 milligrammes for a single day.

THE NEW PENNSYLVANIA LOCOMOTIVES which have recently been placed in service on the New York City electrification of the Pennsylvania Railroad, are to be operated under the supervision of "instructors" familiar with the details of construction of these machines. Men from the engineering apprenticeship course, who have been connected with the railway department of the Electric Company at East Pittsburgh during the construction of the locomotives in the shop and the subsequent operating tests have been sent to New York as instructors.

Standard Locomotive Maintenance Practices

INTERESTING RETURNS FROM SEVERAL PROMINENT RAILROADS INDICATE THE IMPORTANCE OF STANDARDIZATION IN DEFINING LIMITS OF WEAR.

There are certain time-honored features of deterioraton in locomotives generally which through their familiarity to all interested have become what may easily be called examples of standard wear. For instance, it is inevitable that the cylinders at some time must become enlarged to a point where a return must be made to their original diameter; crank pins and axles will be so far reduced below their normal size that they must be renewed; driving box brasses are likewise susceptible, and so on through many other of the component parts. This is the result of wear arising from service which cannot be evaded, and the combat of which constitutes the problem which must be solved before the economical and efficient working of the loco motive can be secured.

Since the various features which require maintenance operations are so generally understood, and in fact anticipated, it would appear that uniformity would be in evidence in defining the permissible limits of wear, but singularly enough there is a wide range of latitude in interpreting the requirements of the latter. It may be said that between various railroads entire agreement exists only in connection with two or three repair items in regard to wear limits, and that in the large majority considerable difference of opinion is in evidence. For this reason it is quite difficult, if not impossible, to compare to any value the cost of repairs between one railroad and another. The elasticity of the subject, as evidenced by these different views, affords an interesting illustration of the high factors of strength and safety which have become so identified with the American locomotive.

In the tabulated returns from ten prominent railroads herewith, the more common items are enumerated, and against each item, under an initial letter representing a separate road, is set the practice of that road in the conduct of the operation indicated. It will be noted that some of the roads interrogated returned no information in the instance of several items in the list; in fact, with the exception of roads "A" and "D," the returns are far from complete, and in cases where these omissions are plentiful it may be safely taken to imply that the road in question has not yet standardized its wear limit renewals. This information is of particular value in itself as indicative, at a glance, of the present status of the standardization of locomotive maintenance practices on ten of the most prominent railroads in the country.

In the table, which will well repay a study, principal interest centers in a comparison of the different views entertained by the various motive power managements in their treatment of the features of wear on which they were questioned. The last column illustrates the greatest difference in opinion between the ten roads.

It will be noted that 3/32 in. practically represents the average opinion in regard to cylinder wear before reboring. The roads which did not return on this item leave it to the discretion of their local shop management, and this applies to all other items where figures are not shown. This 3/32 in. limit represents a very good practice, as 1/16 in., which is the imperative reboring limit on road "A," is scarcely consistent. It is believed that the insistance on reboring with this amount of wear would result in an unwarrantable loss of time and money, because few cylinders, especially on heavy power, are not worn at least that much.

Experience has shown that a cylinder with its bore in what is called an "enameled" condition, has attained an ideal state, and it would be rather unfortunate to turn off this smooth brown oil permeated surface for a variation of 1/16 in. in the diameter of the bore. There is also the likely chance that in the reboring operation the cylinder will be left as badly if not worse out of round than it was before, and minus the brown surface. A recent calipering of one hundred new cylinders showed eighty-seven to be out of round at least 1/16 in., so this is a standard practice which might be left to the shop to perform when considered necessary. Of course, it is based on the idea of saving fuel and returning the engine to as good a condition as it was at first, but the insistance on it is not advisable from what has been said.

Road "A" does not also follow the best practice in its countenancing cylinder bushings with a minimum thickness of ¼ in. The other three roads reporting on this item all assign ⅝ in. as the minimum, and this experience has shown conclusively to be the lightest stock which can be employed without danger of breakage or difficulty in application. In the case of the ¼ in. bushing there is another objection in the fact that it must be closely watched in service and calipered frequently to see that it does not wear to a point where it may give away and cause a damage to the piston or cylinder proper. The majority of the roads agree that the cylinder should first be heated, the expansion thus permitting the bushing to be slipped in, or lightly tapped into position. Only one road advocated drawing the bushing in cold, assigning as a reason that being in contact with the steam its expansion under the heat therefrom would serve to hold it. A bushing extending entirely through the cylinder, with a bearing on both front and back heads, seems to be generally favored as the best practice in this regard.

Road "B" allows piston valve bushings to reach ¼ in. above nominal diameter before renewal, but road "A" in its practice is more consistent, making ⅛ in. the limit. It is a well-known fact that the breakage of piston valve rings is much more frequent in instances where undue clearance exists between the valve and the bushing. Road "D" assigns 7/32 in. as the limit and the others are non-committal, with the exception that all have the bushings renewed on each occasion of heavy repairs to the engine.

Six roads depend on their shops for the renewal of piston heads when worn below the cylinder diameter, and only four roads assign a limit of wear. In the case of road "A" its 1/16 in. is no less than preposterous and it is safe to say that there is not a piston head on that road without a greater clearance than this condemning limit. The idea, of course, is correct beyond dispute in the saving of packing rings, better alignment of reciprocating parts, and more uniform cylinder wear, but it is an example of straining after an impossible ideal in railroad service.

Piston heads can be safely and judiciously allowed to run ⅛ in. below cylinder diameter without appreciable bad results, and in many instances, which have been noted, no ill effect resulted from a much greater wear than this. When it is considered that locomotive maintenance practices are probably more thoroughly standardized on road "A" than any other in the country the effect of this ill-advised 1/16 in. limit of piston head and cylinder bore wear can possibly be appreciated. Furthermore, the various limits are absolutely insisted on and much delay must necessarily ensue through unavailing renewals. It is for this and other reasons that the utmost care should be exercised to evolve common sense standards, and these should have the preliminary approval of all master mechanics interested before becoming the law. It is safe to say that no master mechanic, whether or not of road "A," could find much in justification of this renewal, except the ideal conditions which have been before mentioned as largely unattainable.

In the matter of piston rods there is a rather close approximation between the various roads, an average of about 3/16 in.

CONDEMNING LIMIT OF WEAR FOR VARIOUS LOCOMOTIVE PARTS ON ROADS DESIGNATED "A" TO "J."

Standardized Operations.	A	B	C	D	E	F	G	H	I	J	Opinion differs.
Cylinders to be rebored (when out of round)	2-32″		3-32″			3-32″				3-32″	1-32″
Cylinders to be bushed (when worn)	10-16″	7-16″	12-16″	6-16″	8-16″		12-16″	8-16″		12-16″	5-16″
Minimum thickness of bushing	4-16″	10-16″			10-16″		10-16″				6-16″
Minimum thickness of cylinder wall		12-16″			10-16″		10-16″				2-16″
Piston valve bushings to be renewed (when worn)	4-32″	8-32″		7-32″							4-32″
Piston heads (when worn below cylinder diameter)	2-32″		6-32″	3-32″		4-32″					4-32″
Piston rods (when worn below original diameter)	2-16″	3-16″	3-16″	3-16″	4-16″	4-16″	3-16″	3-16″		4-16″	2-16″
Valve stem (" " " " ")	2-16″			3-16″	2-16″						1-16″
Slide valve flanges (minimum thickness)	10-16″		8-16″	10-16″	10-16″			6-16″			4-16″
Minimum height of valve seat (before applying false seat)								7-16″		7-16″	
Side rod bushings (when worn above pin)				1-16″							
Crank pins (when worn below original diameter)	8-32″	6-32″		10-32″	8-32″	3-32″	8-32″	12-32″		when 5 years old.	9-32″
Driving box brasses (minimum thickness in crown)	1⅜″	1⅛″									2-8″
Driving axles (when worn below original diameter)	½″	⅜″		⅜″	½″	½″	⅜″	½″	½″	½″	1-8″
Engine truck axles (when worn below original diameter)	½″	⅜″		¼″					½″		1-8″
Tender truck axles (" " " " ")	¼″	¼″		¼″					¼″		

reduction in the original diameter being the condemning limit. These limits given in every case are irrespective of the original diameter of the rod, and apply equally to one of 2½ in. and to one of 4 in. There is nothing to criticise in these practices as a reduction of 3/16 in. in a piston rod naturally implies an age where metal fatigue or crystallization becomes in order, and it is a good precautionary measure to remove, anneal and rework them thoroughly before turning down for use in engines carrying smaller diameter rods.

No limit is set, with one exception, on the wear of side rod bushings, and, in this, road "D" is working to a refinement quite hard to secure as its condemning limit of 1/16 in. is generally present on freight engines in a week and passenger power in a month. Unless the care of the driving box wedges is far more to the point than is exercised on the majority of American railroads the maintenance of side rod bushings as desired by this road becomes a matter of sheer impossibility. On the presumption that standard practices once promulgated are insisted on, it would be well to discard this one, and try to attain the end by work underneath the engine. Otherwise the roundhouse floor will be bestrewn with rods on all occasions, and much serviceable power will be idle.

Driving and truck axles do not show much variance in the views entertained, no doubt arising from the fact that these parts are more generally discussed than others and certain general limitations in dimensions have been adopted to govern them, but it will be noted that there is a difference of opinion of 9/32 in. in regard to crank pins. Road "H" allows a reduction of ⅜ in. from the original diameter before renewal. This is so very much greater than the next nearest, ¼ in., which is the limit on three other roads, that no conclusion can be reached but that the pins on road "H" are of excessively heavy and unwarranted stock.

Driving box brasses are not commented on in this connection except by roads "A" and "B," and both of these allow too low a minimum of thickness in the crown before renewal; that is, 1⅜ in. and 1⅛ in., respectively. There can be no question among those who have intelligently followed this detail but that 1½ in. is the lowest permissible thickness which any driving box brass should be allowed to run. It is unfortunately a common practice, which a walk through any shop will substantiate, to rebore these on the occasion of general repairs until they "clean up," and irrespective of what thickness the remaining metal may have. This would very likely be in evidence on the eight roads not reporting on this item as they do not have instructions governing the procedure in relation to this part.

This interesting question of standardizing maintenance practices has been presented merely as illustrative of the views entertained by widely separate roads in consideration of the same subject, but it becomes more vital when confined to a single road. Only during a comparatively recent time has the matter been given attention, except in a desultory fashion, but it is now quite evident from the replies received from various roads that it is being vigorously attacked in many quarters and endowed with the importance which it deserves.

The plan which is now being followed with much success in at least two instances is to print the various repair operations and wear limits on standard card forms which are distributed among the master mechanics, general foremen and possibly the gang foremen, but at all events they are accessible wherever required. Before sending these out, however, as standard operation, they have a preliminary circulation, as blue prints, among those interested, who are free to criticise as they please. Not until all the criticisms are returned and the proposed card revised as may be necessary does the practice become standard. Only the more common operations should be standardized, and the matter must be proceeded with cautiously, but it is worth the experiment in the certainty of results and above all in the circulation of the most economical and labor-saving ways of doing work.

THE WORLD'S LARGEST ELECTRIC CLOCK.—An electric clock which is claimed to be the largest in existence has been constructed by Messrs. Gent & Co., Limited, of Leicester, for the new buildings of the Royal Liver Friendly Society, Liverpool. It has four dials, and is to be erected in a position 220 ft. above the ground. The hands are made of copper, and those for the minutes, measuring 14 ft. long by 3 ft. wide at their broadest part, have been specially strengthened with a 9 in. gun metal backbone. The opal faces have been built to withstand a wind pressure of over 11 tons. The outer circle of the dials, which are 25 ft. in diameter, is made up of 12 sections, each measuring 6 ft. 3 in. by 5 ft. 6 in., and weighing 5½ cwt. The total weight of the framework of each dial is 3½ tons. The dials will be electrically illuminated, and the current will be switched on and off automatically at dusk and dawn.

NEW UNION STATION IN CHICAGO.—Work on the construction of a new passenger station in Chicago on the site of the present Union Depot will begin early next spring, and will be pushed to completion with all possible rapidity. The building itself will cost $5,000,000, and the outlay for the purchase of the land needed will bring the total investment up to $20,000,000. Negotiations relative to the project, which have been in progress for a long time, have now reached a point where the five railroad systems interested are prepared to make application within sixty days for a permit to begin building operations. Darius Miller, president of the Chicago, Burlington and Quincy Railroad, has declared that the erection of a new depot is assured.

AUTOMATIC GATE REGISTER.—The Pennsylvania Railroad is said to be considering the installation at Union Station, Pittsburg, of an ingenious device for registering automatically the number of passengers passing through the trainshed gates. The apparatus comprises a stream of compressed air which plays continuously across the passageway and holds open a circuit, except when it is interrupted by the body of the person traversing the passageway. These interruptions register the number of persons passing.

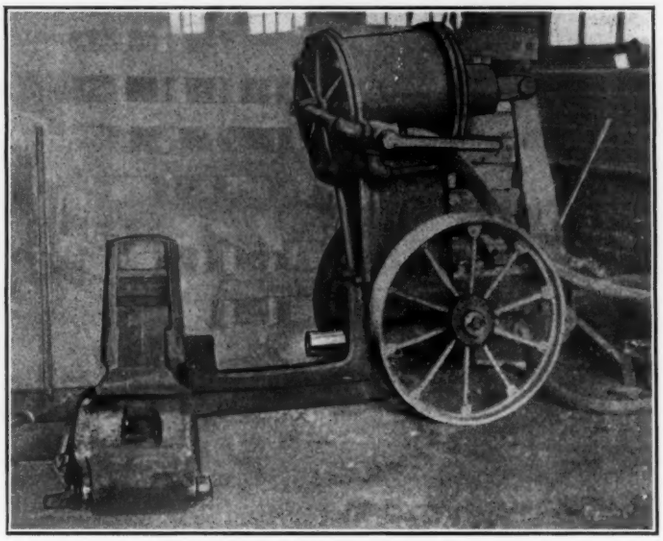
PNEUMATIC RIVETER FOR COUPLER YOKES

NEW YORK, NEW HAVEN & HARTFORD R. R.

The coupler repair problem is not by any means the least important in car shop work. On a road having say 20,000 cars, it amounts on an average to some 3,000 couplers in a year. Of this 75 per cent. are removed due to the failure of the coupler proper, and generally resulting from accident. The coupler yoke is only found defective to the extent of about 25 per cent., but in all cases the parts must necessarily be stripped and reassembled after whatever renewal has been made.

In line with the progressiveness which is so characteristic of car repair work on the New York, New Haven & Hartford Railroad, this particular item has been the subject of much attention at the Readville shops of that company, and through careful attention to working out all details the minimum has been obtained in both items of time and cost. One day in each week, generally Friday or Saturday, is found amply sufficient to clean up the previous six days' accumulation of broken couplers from all points on the system and to place them in the Readville storehouse for redistribution on requisition. The entire labor cost is but 19 cents per coupler, including stripping, renewal of either yoke or coupler, riveting up, and for the necessary movement of the parts about the plant.

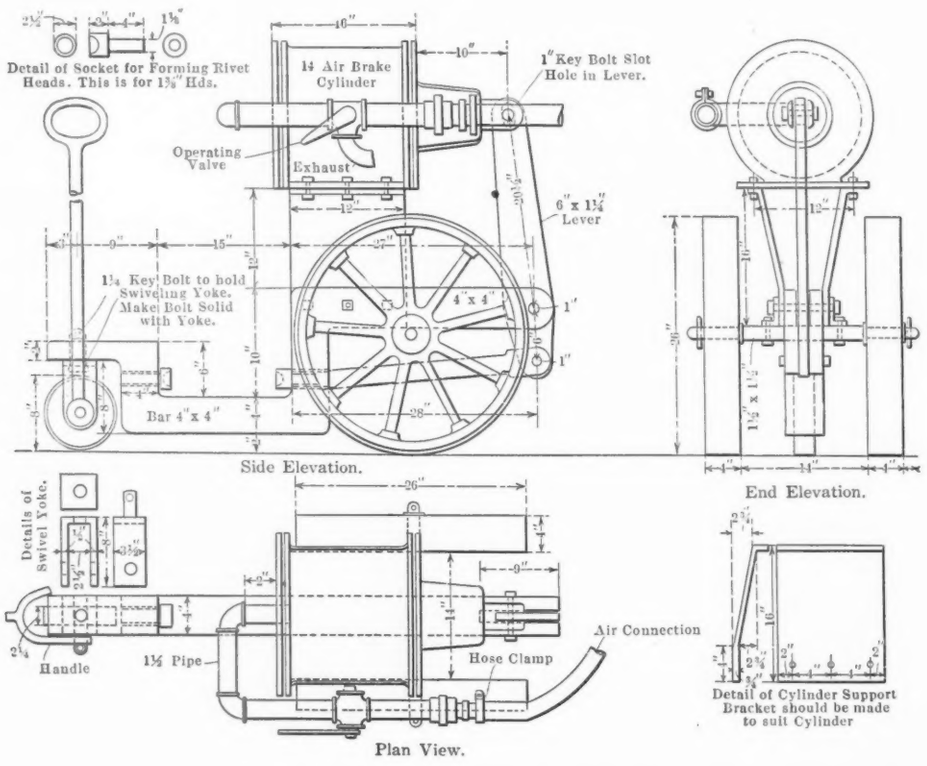
This very low cost is largely made possible through the pneumatic riveting machine, a home-made affair, which is herein shown. Its construction is very simple, as is clearly evident from the drawing and illustration. It will be noted that the arrangement of the frame is such that the coupler does not have to be lifted, as was formerly the case when the yoke rivets were headed under a steam hammer. All the labor required is to upend and drop it transversely across the depressed part of the couplers, varying from 2 to 3 rivets each, is considered as only a fair day's work for it. Two men perform the entire operation of temporarily bolting the yoke and coupler, heating and applying the rivets, handling the riveter and disposing of the coupler



A SIMPLE AND EFFICIENT RIVETER.

outside of the shop. In shops where much repair work of this description is done this cheap and adequate device will prove of the greatest value.

GETTING OUT A BROKEN TAP is considered a very hard job, and especially where the tap is small or in a finished piece of work


Detail of Socket for Forming Rivet Heads. This is for 1⅜" Hds.
14 Air Brake Cylinder
1" Key Bolt Slot Hole in Lever.
Operating Valve
Exhaust
6" x 1¼" Lever
1¼ Key Bolt to hold Swiveling Yoke. Make Bolt Solid with Yoke.
4" x 4"
Bar 4" x 4"
Side Elevation.
End Elevation.
Details of Swivel Yoke.
Handle
1½ Pipe
Hose Clamp
Air Connection
Plan View.
Detail of Cylinder Support Bracket should be made to suit Cylinder

DETAIL ARRANGEMENT OF PNEUMATIC RIVETER.

riveter frame in line with the rivet socket, and the rivets are headed through the action of a 14-in. brake cylinder piston under 80 lbs. pressure, which is that of the shop air line, and in a single thrust.

The capacity of this very efficient tool is enormous, 200 that cannot be heated in order to anneal the tap. To make this task an easy one, pour muriatic acid into the hole. Leave it there for about four or five minutes and enough of the tap and the hole is eaten away to loosen the tap, which can then be backed out.

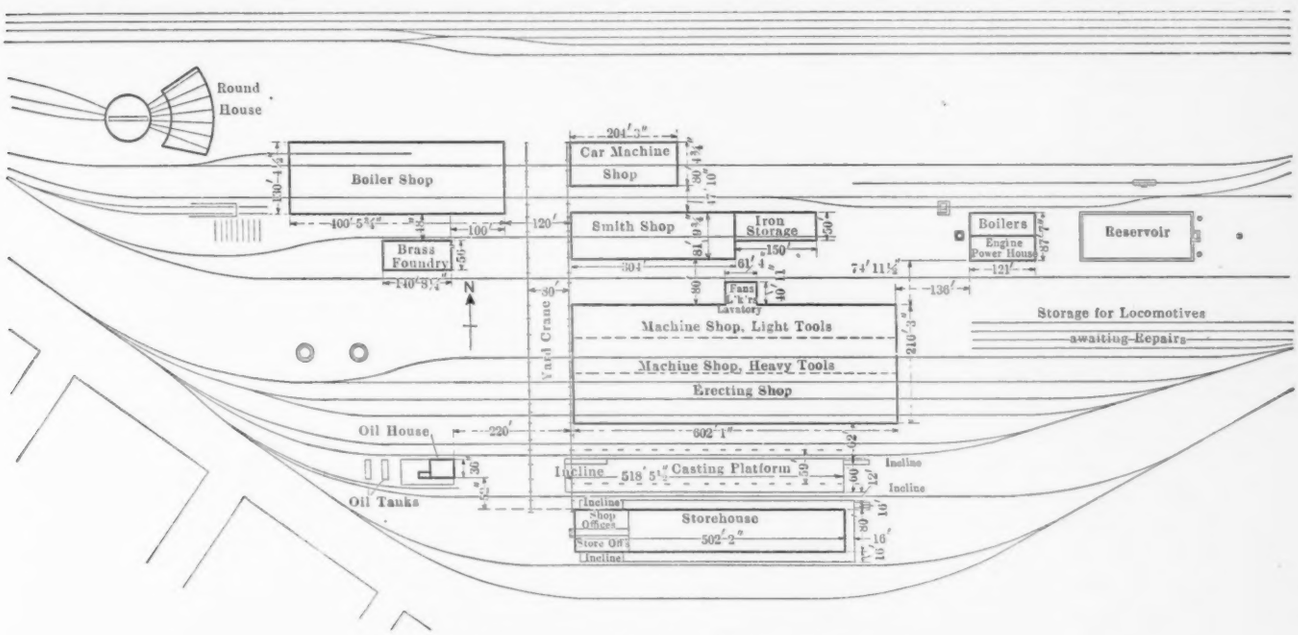
New Locomotive Repair Shops at Havelock, Neb.

THE OLD LOCOMOTIVE REPAIR SHOPS ON THE CHICAGO, BURLINGTON & QUINCY RAILROAD AT HAVELOCK, NEB., HAVE BEEN TRANSFORMED INTO PRACTICALLY A COMPLETE NEW PLANT BY THE ERECTION OF A NEW ERECTING AND MACHINE SHOP; A LARGE SYSTEM STORE HOUSE; A COMPLETE POWER HOUSE AND A SYSTEM OIL DISTRIBUTING STATION.

On the lines of the Burlington west of the Missouri River, the introduction of large Mallet locomotives, together with a large increase in the number and size of other locomotives, has brought about a condition which made it imperative to furnish decidedly more extensive and complete repair facilities than were provided by the shops which had served these lines in the past. These shops, howver, originally constructed in 1894, were in advance of their time in many features of general design and were in far too good condition to be razed, therefore the new shop plant was designed so as to make use of the present buildings in the following manner: The present machine and erecting shop has been replaced with an entirely new and thoroughly up-to-date structure, and the building now used for this work is changed over for boiler shop use. The present boiler shop is then to be made into a new forge shop and the present forge shop is to be changed into a car machine shop. Since in the new machine shop all of the tools will be electrically driven, most of them by individual motors, and also because a number of new cranes, elevators, increased forge shop equipment, etc., that will require a decided increase in power house capacity, the old power house was abandoned and transformed into a brass foundry and a complete new power house has been constructed. At the same time a new storehouse of exceptional capacity, which is to be a central distributing point for all the lines west of the Missouri River, has also been built. A large new oil house forms the fourth building of the new list.

The use of the old buildings for the purposes mentioned has made it impossible to obtain an ideal arrangement, so far as the inter-relation of the various buildings are concerned, but nevertheless by means of an 80 ft. traveling yard crane, which serves all of the buildings of the plant, most of the difficulties of inter-shop transportation have been solved and with the exception of a single feature of the necessity of transporting boilers out of the erecting shop under the yard crane then about 300 ft. by means of the yard crane and again in the boiler shop, there can be but little objection raised to the arrangement. When it is considered that a building provided with cranes and suited in every way for boiler shop work, is already in existence, it is easily seen that the expense and delay incident to this transportation of boilers is not sufficient to make it advisable to construct a new building for these repairs.

A study of the illustration will show that the yard crane is the main artery of the transportation system and that from it a connection can be made into all buildings with ease by means of the numerous tracks passing under it. A large extending platform, on which it is proposed to store the heavier parts, extends underneath the yard crane and is provided with a crane of its own, which also extends far enough underneath the yard crane runway to permit the transfer of heavy castings from one crane to another without difficulty.



GENERAL ARRANGEMENT OF NEW SHOPS AT HAVELOCK.

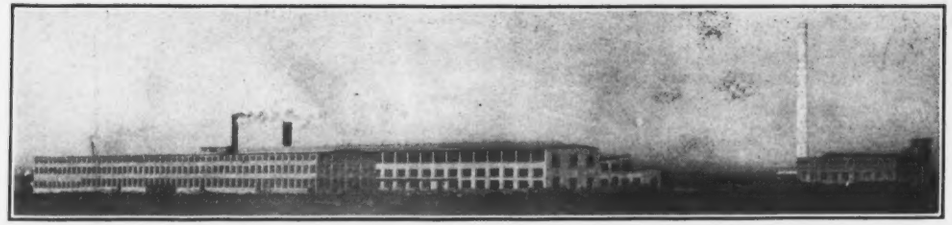
Some surprise may be occasioned by the location of the power house, but when it is considered that this is adjacent to the smith shop and the large machine shop, the two shops which require its output to the largest extent, and also that it was located with the idea of possible future extension in the nature of freight and passenger car repair shops, it will be seen that its location cannot be justly criticised. ,

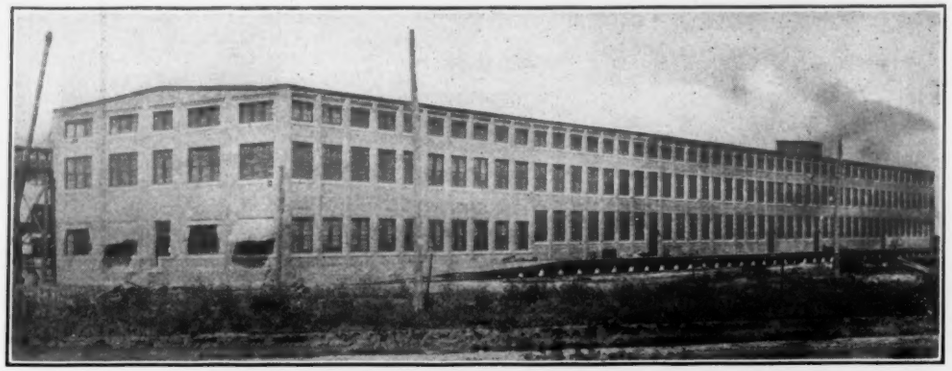
Erecting and Machine Shop.

One of the illustrations shows the cross section of this very large building, which is devoted entirely to erecting shop and machine work. It is of the longitudinal type, three tracks running the entire length of the erecting shop, which occupies 90 ft. on one side of the building. Adjacent to this is a heavy machine bay 60 ft. in width, back of which is another 60 ft. bay for the lighter tools. The building is over 600 ft. in length.

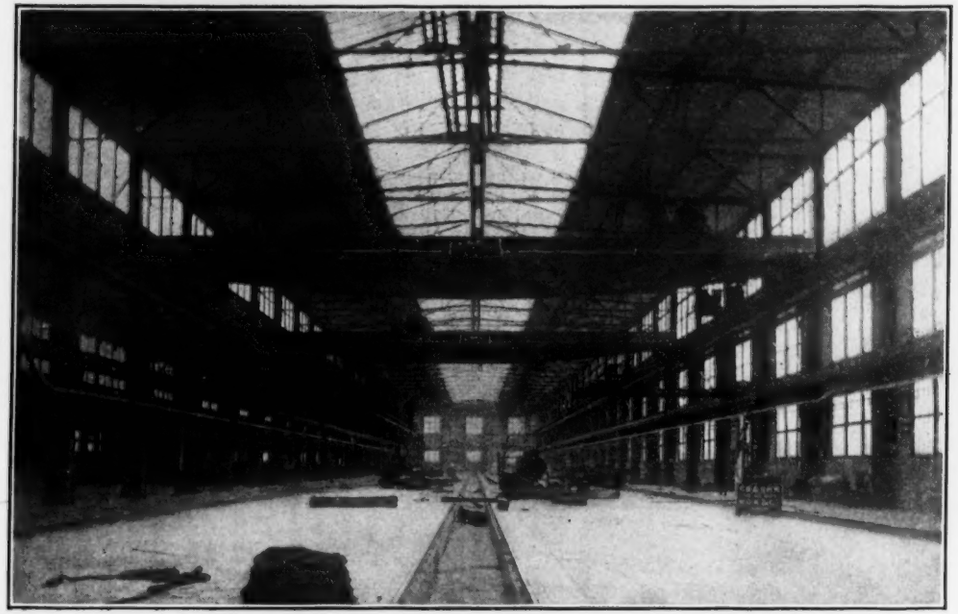
Over the erecting shop there are two 4-motor girder cranes, each having a main hoist capacity of 75 tons and an auxiliary capacity of 15 tons. In addition to this over the outside tracks there are four, two on either side, 3-motor, 3-ton traveling wall cranes. Over the middle or heavy machine bay there is one 3-motor girder crane, having a capacity of 10 tons and a span of

INTERIOR OF LIGHT MACHINE BAY.





ABOVE—GENERAL VIEW OF NEW BUILDINGS. BELOW—STOREHOUSE.



GENERAL VIEW OF ERECTING SHOP.

INTERIOR OF HEAVY MACHINE BAY.

58 ft. As soon as the shop requirements indicate its necessity another crane of similar capacity will be installed on the same run-way. All cranes throughout the plant were built by Niles-Bement-Pond.

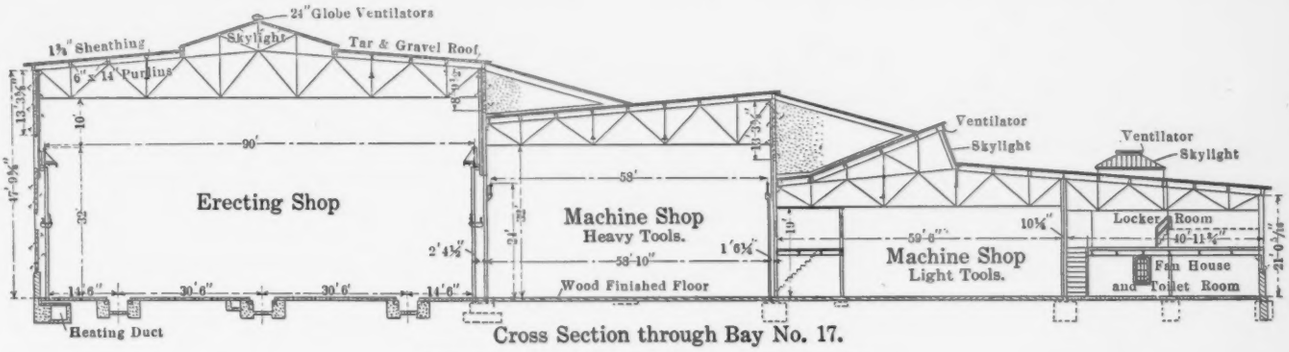
A very substantial steel construction forms the frame work of the building. The enclosing walls are constructed of 1 in. channel studding secured with iron straps to the steel girths and covered with galvanized expanded metal wired on. To the expanded metal is applied four coats or layers of cement plaster, each ¾ inch thick, making a wall of good weather resisting qualities and of sufficient thickness to embed the steel.

A concrete floor has been provided in the erecting shop, while in the machine bays the floor consists of a course of 3 in. Burnettized Oregon fir laid on tamped sand, the boards being nailed together. Over this sub-floor is laid a wearing surface of 1⅛ in. maple factory flooring. The roof of the building consists of 2 in. sheathing laid on 6 x 14 in. purlins and covered with 5-ply pitch felt and gravel laid according to the Barret specifications.

arrangement of the stored parts, it will prove sufficient. In some cases, as for instance at Readville, this question has been solved by storage pits below the floor. This scheme, however, requires two separate handlings of material that does not have to go to the lye vats and necessitates a removable section of flooring over the storage pits. It is quite possible, however, that a saving of practically 20 ft. in crane length and in the width of the shop may offset this increase in cost.

LOCATION AND ARRANGEMENT OF MACHINE TOOLS.

In the heavy machine bay the tools are all individual motor driven, both direct current and variable speed motors and induction constant speed motors being used, depending upon the tool that is to be driven, the latter being employed when the tool contains within itself a sufficient speed variation and the former where it is necessary to have speed changes on the motor in order to obtain the required range on the tool. In the light machine bay all of the smaller tools are grouped, these in most cases being arranged for group driving from an overhead shaft,



Cross Section through Bay No. 17.

SECTION OF NEW MACHINE AND ERECTING SHOP.

Reference to the three photographs showing the interior of the three bays clearly indicate that the value of generous natural lighting area has been fully appreciated by the designers. In the outside wall of the erecting shop above the crane runway it will be seen that practically the whole area is given up to glass. Below this the windows occupy over 75 per cent. of the whole area. On the opposite side of the erecting shop the extension of this section above the roof of the next bay is practically all of lighting area. In addition there is a skylight 31 ft. in width continuing the full length of the shop in the center. Altogether this makes this one of the best lighted erecting shops in the country. In the heavy machine bay the lighting is all from the vertical section of the saw-tooth roof, the windows being 13 ft. 3½ in. in height, and continuous for the full length of the shop. In the light tool bay the side windows are duplicates of those below the crane runway in the erecting shop and in addition a saw-tooth roof arrangement gives an excellent skylight near the center.

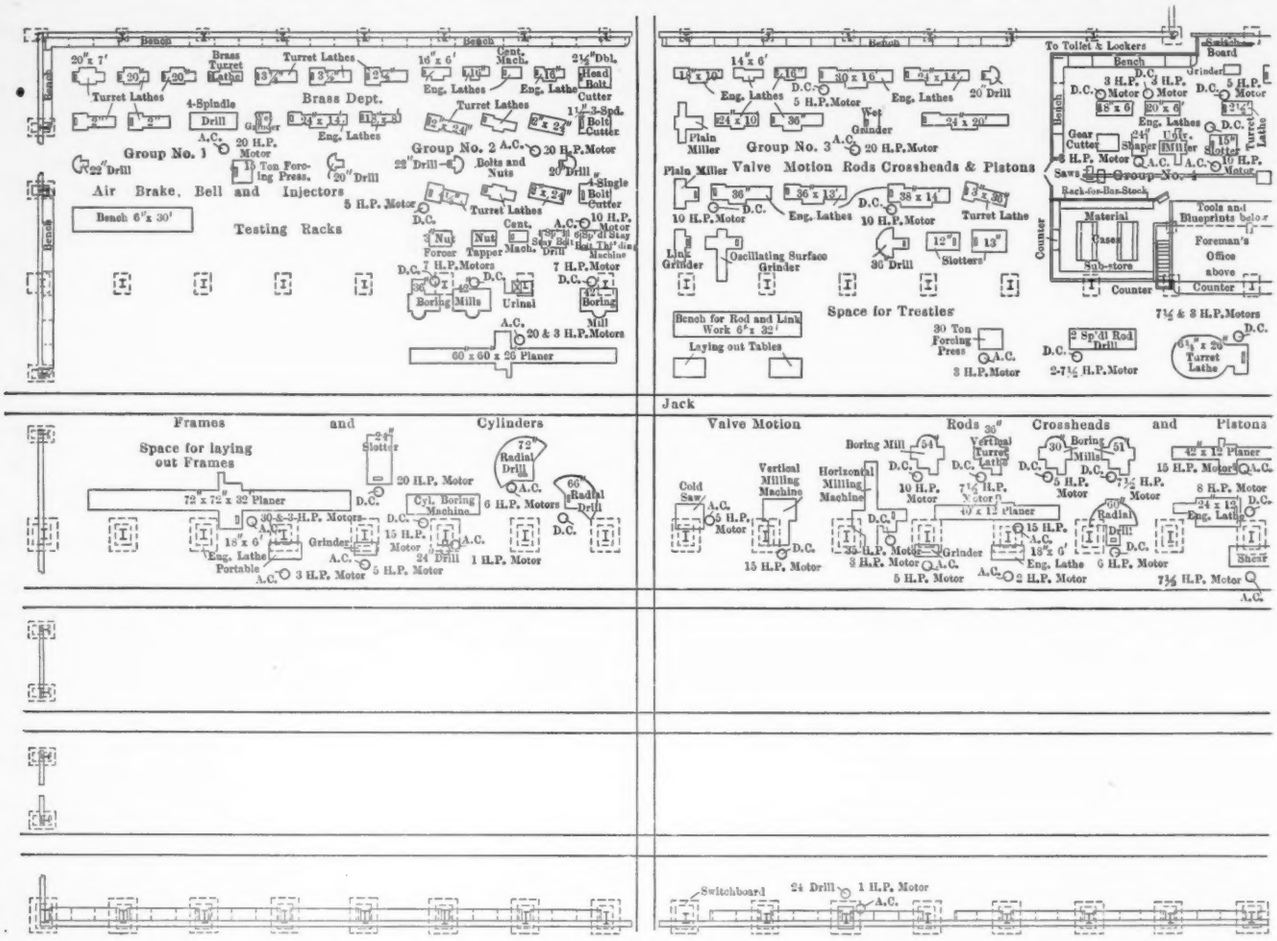
In the erecting shop, pits are provided on all three tracks, differing in this respect from most other longitudinal shops. They are 570 ft. long, located at 30 ft. 6 in. centers, the side pits being 14 ft. 6 in. from the wall. This gives an unusually large space between pits, allowing the storage of material taken from stripped locomotives which does not need repairs and still at the same time leaving ample clearance for workmen. The subject of the proper place for storing material of this nature is one on which there seems to be but little uniform opinion. It is, of course, preferable to store piping, lagging, steam chest covers, and other parts, which are to be again applied without repairs, in the immediate vicinity of the locomotive and in a place that will require the least number of handlings. With a longitudinal shop this, of course, can be done perfectly by leaving enough space between pits, but, on the other hand, space between pits means increased length of cranes and increased complication of roof trusses and other expenses, which mount up very rapidly and make it necessary to arrive at a compromise. Thirty feet and six inches, as is found in this shop, is the widest space of which we have any record and probably with proper care in the

although there are some individual driven tools in this section. There is no overhead traveling crane in the light machine bay and jib cranes, etc., will be installed for the handling of the work.

Referring to the illustration showing the arrangement of the tools, and beginning at the right end of the shop, it will be seen that a space of about 72 ft. along one side of the heavy machine bay is occupied by the lye vat and cleaning platforms. In addition to the service of the traveling crane there are two 20 ft. jib cranes arranged to handle material in and out of the vat. At this point there are two transverse tracks running between the outside pit in the erecting shop and the track that exends the full length along the center of the heavy machine bay. This permits the bringing of the material to the vat on push cars and transferring them out on the line of travel along the center track while they are getting unloaded. The other half of the heavy machine bay opposite the lye vat, as well as the next 80 ft. extending up to the transverse track that passes entirely across the shop and to the outside, is taken up by tools and space for the driving wheel work. The tracks for storing the wheels will be noted and the various lathes, presses and boring mills are indicated on the drawing. Of course in this shop a number of the tools have been transferred from the present shop. The new tools for wheel work include a 96 in. boring mill, a 100 in. quartering machine and a 42 in. car wheel lathe. In this section the only induction motors are on the quartering machine, the 600 ton hydraulic press and the 200 ton wheel press, in addition to the small grinder.

In the light machine tool bay, just back of the wheel section, are grouped a general collection of tools for miscellaneous work. These are all belted to a line shafting driven by a 20 h.p. induction motor forming group No. 6. Driving box and shoe and wedge work is taken care of by the tools occupying the next 112 ft. of the heavy machine bay. It will be noticed that there is a cylinder boring machine also located in this section, as well as a 96 in. and a 54 in. boring mill, which will be used for tire turning. In the light machine bay, just back of this section, is a tin and pipe department, with tools, benches, forges, etc.

The next group of tools is for rods, cross heads and piston



ARRANGEMENT OF TOOLS AND TRACKS IN NEW

work, taking up about 135 ft. in the heavy machine tool bay. Just beyond these are the tools for valve motion work, a liberal open space and large benches being provided in this neighborhood for fitting. In the light tool bay, back of these groups, is a tool room, which is liberal in size and very well arranged, there being a number of direct driven tools, as well as two groups, Nos. 4 and 5, located in the space next to the outside wall. Group No. 3 in the light machine tool bay includes the tools for valve motion, rods, cross head and piston work of a light character. This group is driven by a 20 h.p. alternating current motor. At this point there is another transverse track extending through the shop. The remaining 150 ft. of the shop is given up to large tools in the heavy bay for frames and cylinders, sufficient open floor space being provided for laying out and handling. Bolt and nut, air brake, etc., work is performed on the tools in groups Nos. 1 and 2 in the light machine tool bay in this end of the building.

It will also be noted that along the outer wall of the erecting shop there are two 24 in. drills driven by constant speed motors, on which emergency work can be performed by the erecting shop men. A number of small lathes, punch and shear, saw, grinders, etc., are placed inside of the columns on the other side of the erecting shop for small emergency work. There are also several portable lathes.

A study of this tool arrangement indicates the care that has been taken to reduce the transportation of material to a minimum. In each section there will be found tools suited for doing all parts of the work on any part of a locomotive, the lighter sections being machined on the small tools in the outside bay and the heavier work on the heavy tools under the crane and a space provided at each point for the assembling. For instance, all motion work is collected at the center of the shop; the driving box, shoe and wedge work is immediately adjacent to the driving wheel work, as it should be, and also near the cleaning vat, and so it goes throughout the shop.

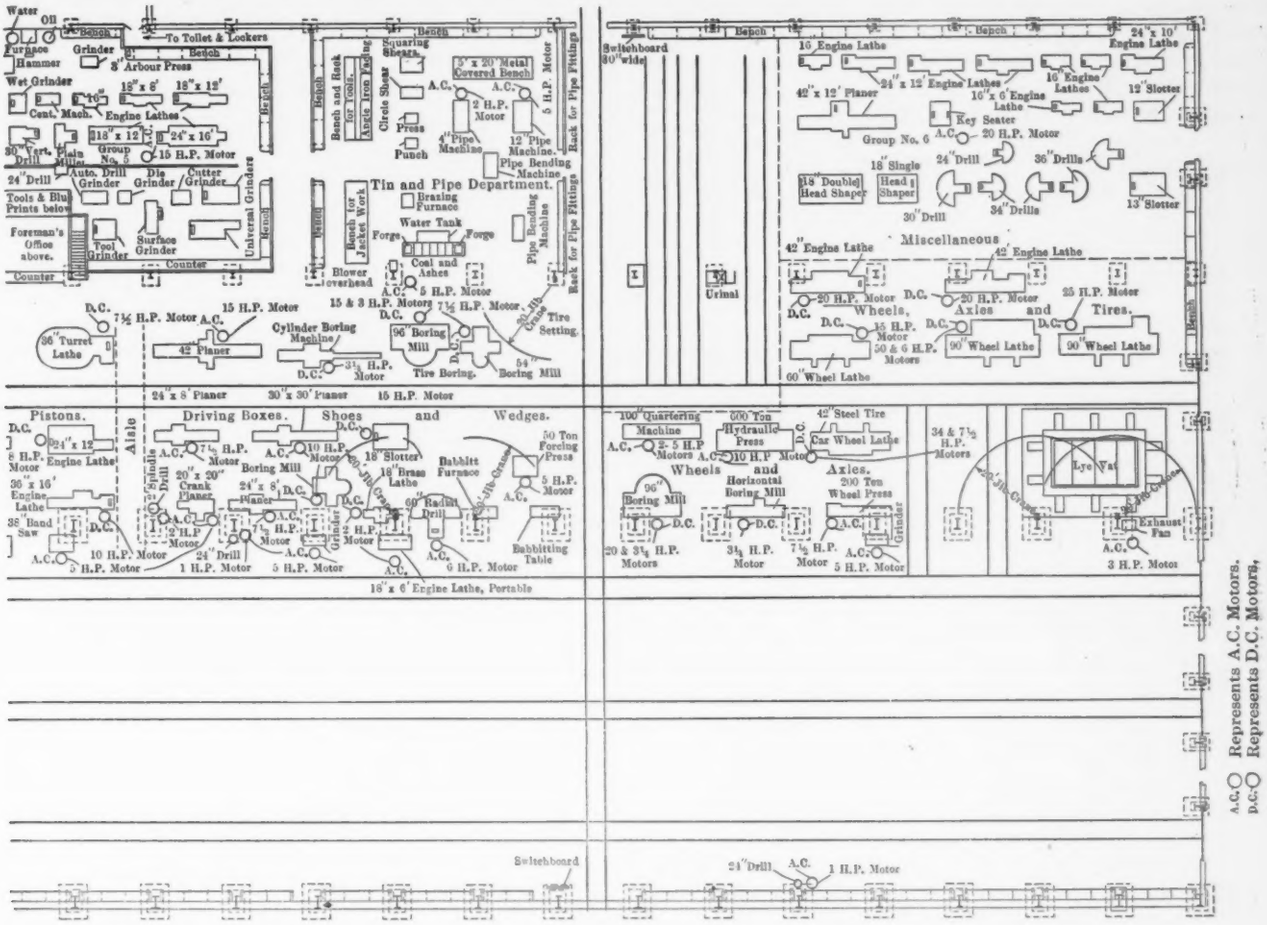
In a later issue, after the shop has been in operation for some time, we hope to be able to discuss this feature in view of the actual work being performed.

Extending out from the light machine tool bay in the center of the shop is a building about 41 x 61 ft., arranged in two floors, in which is located the fans, their coils and air intakes, and also a laboratory and a large locker room. The air from the fans is discharged through an underground conduit along one side of the erecting shop with exits close to the posts and just inside of the wall. For the other bays of the shop the hot air is conveyed through overhead galvanized iron piping with discharges at every alternate posts in all bays.

STOREHOUSE.

One of the largest rairload storehouses in the country forms part of this plant. It is a building 80 ft. in width, 500 ft. long, and three stories high, parallel to and 150 ft. away from the erecting shop. The building is of slow burning mill construction with brick walls and is surrounded on three sides by a platform 16 ft. in width. 100 ft. of the first and second floors at the west end of the building is reserved for office use. On the first floor are situated the quarters of the superintendent of shop and the storekeeper, while on the scond floor are located the stationer, doctor, who is provided with an emergency hospital fully equipped, telephone exchange, quarters for the apprentice school, and a meeting room.

This storehouse is intended to be the main distributing center for all material used on the Western Grand Division of the railroad. On the first floor are located cases for holding the material handled in the largest quanties, as well as the receiving and shipping rooms. On the second floor is the stock of stationery and material cases for handling the small stock. The third floor is given up to the storage of material in original packages, which is not worked over in the storehouse, or is of a bulky nature. Two motor driven elevators are provided, serv-



MACHINE AND ERECTING SHOP AT HAVELOCK.

ing all three floors, one being located in the receiving room on the first floor and the other in the shipping room.

An interesting feature of the design of this building is that the form of material case to be used was first adopted and then the windows and framing were designed to suit the cases. These cases are 5 ft. in width at the bottom and are separatel by a space of the same width, making the spacing of windows at 10 ft. centers. The windows themselves are 7 ft. in width and located directly opposite the aisle between the cases.

The heating of this building is by direct radiation in the office section and by indirect system, having duplicate fans, in the storeroom section. It is lighted throughout by incandescent lamps.

Just to the north of the storehouse, and separated from the platform on that side by the clearance of one track, is a large casting platform 60 ft. in width and 518 ft. long, built at car floor level. This, and the track serving it to the north, are covered by a 10 ton, 59 ft. girder crane, the runway of which extends far enough under the yard crane to permit the transfer of material between the two without rehandling. Between this platform and the erecting shop there is a space of 62 ft. in which there are two tracks, the remainder of the space next to the erecting shop itself being clear and to be used for the storage of little used material or parts.

OIL HOUSE.

Situated west of the erecting shop and storehouse at a distance of 220 ft. is the oil house. This structure, which is built entirely of concrete below the platform line, has side walls of brick and roof of concrete, water proofed with a five ply pitch felt and gravel covering. Special attention has been given to making the building entirely fireproof and no combustible material has been used anywhere in its construction. Tanks for storage of the various oils with the exception of kerosene and gasolene are located in the basement of the building and under the platform. Kerosene and gasolene are stored outside in two elevated tanks, each having a capacity of 20,000 gallons. These oils are handled to the storage tanks from cars by motor driven power pumps located in a separate compartment on the west side of the building. From the tanks kerosene and gasolene is distributed and barrels filled by gravity. For handling oils stored in the tanks located in the basement and used in considerable quantities, five Gilbert and Barker power pumps, each having a capacity of 40 gallons per minute, are provided. Ten Bowser self-measuring pumps are also located in the pump room for handling as many different kinds of oils in small quantities. The power pumps are driven from line shafting run by a 3 horsepower 440 volt Westinghouse A. C. motor.

The tank capacities and the list of oils to be handled is as follows:

Kerosene	20,000	gallons
Gasoline	20,000	"
Fuel	24,000	"
Car	24,000	"
Valve	12,000	"
Mineral Seal	8,000	"
Black	500	"
Gas Engine	500	"
Renown Engine	500	"
Franklin Engine	500	"
Linseed	500	"

A compartment 20 x 36 ft. is provided in the building for the storage of baled waste. For the easy handling of this material an overhead trolley arrangement has been installed.

POWER HOUSE.

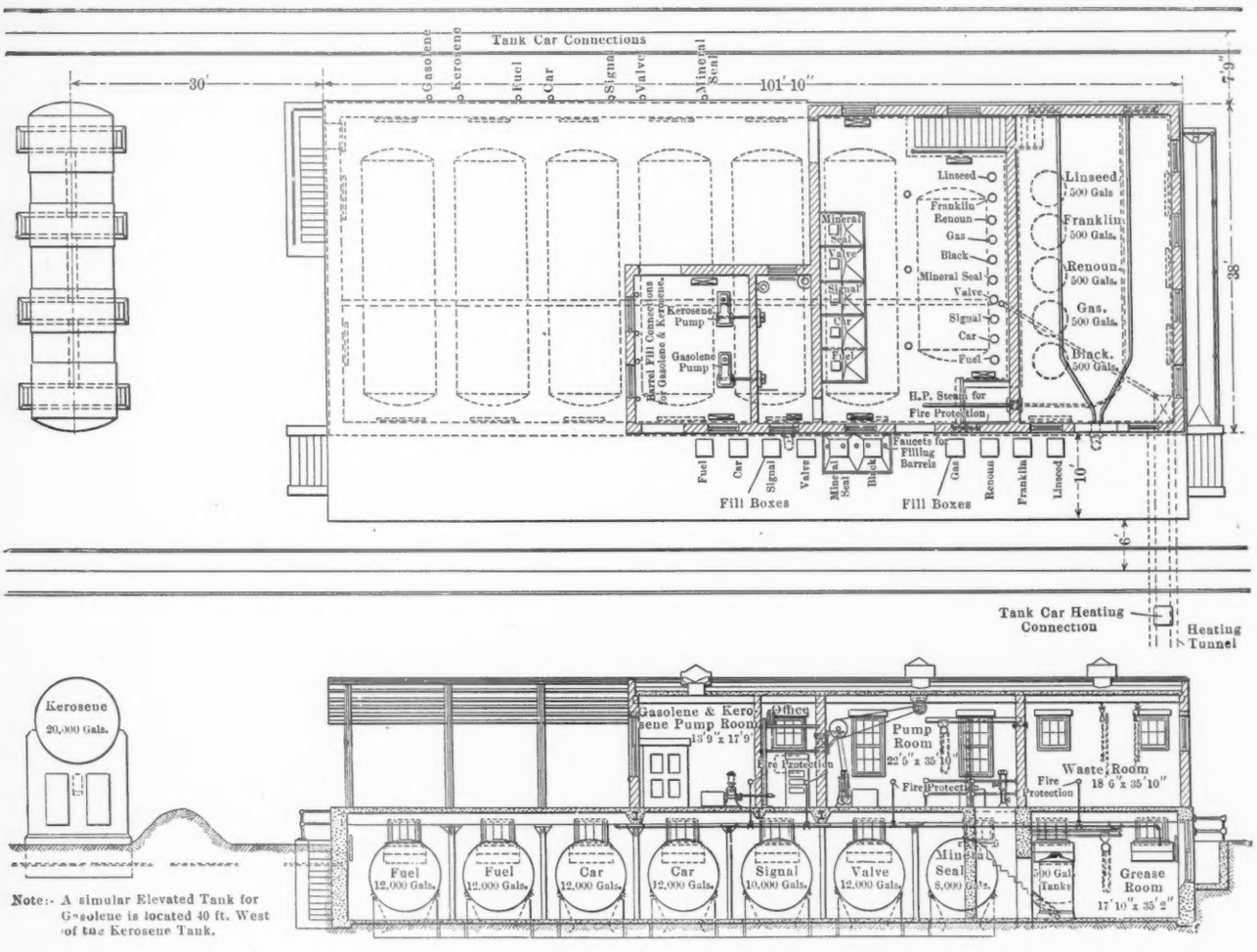
A power house, thoroughly modern in every respect, forms not the least important part of this shop plant. Its location can be seen by reference to the general view. It is a brick structure, with a concrete roof covered with five-ply felt pitch and gravel

covering. It measures 87 ft. 7 in. x 120 ft. outside dimensions, and is divided into practically two equal longitudinal sections, the one to the north being the boiler room and the other the engine room. In the former are at present provided four 400 h.p. Sterling boilers, arranged in two batteries; space is also provided for the installation of two additional units of the same size. The boilers are equipped with Green chain grate stokers and furnish saturated steam at 150 lbs. pressure. Special attention has been given to the mchanical handling of coal and ashes. The coal is discharged into a track hopper just outside the power house, and conveyed to the concrete bunkers over the boilers by an inclined belt conveyor. From these hoppers it is fed directly to the chain grates by gravity. The ashes discharge into small ash cars located in a tunnel beneath the boilers, which are hoisted to an overhead hopper, into which they are automatically dumped. From this hopper they are discharged into the ash cars outside of the building without further handling.

The other boiler room equipment consists of two Blake 14 x 8 x 12 in. plunger type duplex boiler feed pumps and a 3,000 h.p. Stillwell feed water heater, the latter being located on a platform over the feed pumps. The stack is 200 ft. in height, built of reinforced concrete, the construction work being by the General Concrete Construction Co. A Locke damper regulator has also been installed.

In the engine room there is one 750 k. v. a. Westinghouse generator driven by a Parsons turbine. Foundations and space are also provided for two additional turbines of the same size, to serve future requirements. A 200 kw. Westinghouse generator direct connected to a 300 h.p. Erie Ball cross compound engine has been transferred from the old power house. There is also one 100 kw. and one 200 kw. Westinghouse induction motor generator set, which furnish direct current at 220 volts for the operation of the motors of this type on some of the machine tools, as well as all crane motors. The current from the alternators is 3-phase, 60 cycle, at 440 volts, is used for general lighting and for all constant speed motors throughout the plant. In addition a 25 kw., 125 volt Curtis turbo generator and a 25 kw., 125 volt Westinghouse motor generator set, are provided for exciting and auxiliary lighting purposes. In the engine room are also found an Ingersoll-Sargent cross compound two stage class G air compressor having a capacity of 2,100 cu. ft. of free air per minute, as well as a Franklin duplex two-stage compressor of 2,000 cu. ft. capacity.

In the basement of the engine room are the pumps for water and fire service, as well as a Westinghouse LeBlanc motor



PLAN AND ELEVATION OF OIL HOUSE AT HAVELOCK.

Adjacent to the power house is a large concrete reservoir of 1,000,000 gallons capacity, which in addition to the water supply is also used for cooling purposes, the discharge from the turbine condensor being sprayed through Koerting nozzles.

All piping between the power house and various buildings is carried in a concrete tunnel or in conduits. The wiring is entirely overhead, being carried on steel towers and wooden poles.

YARD CRANE.

The yard crane is of 40 tons capacity, the runways being 30 ft. in height and 80 ft. apart. It adjoins the machine and erecting, smith and car shops, and is but 40 ft. away from the end of the boiler shop, and also, as above mentioned, serves the end of the casting platform. Passing underneath it at right angles there are 11 tracks, of which two serve the casting platform, three enter the erecting shop, one passes through the heavy machine bay, one through the smith shop and two enter the boiler shop. This makes it possible to transfer any heavy material from a car on any track directly to the shop wherein it is to

be used. This and all other cranes in the plant were furnished by Niles-Bement-Pond Co.

BOILER AND SMITH SHOPS.

The old erecting shop and the old boiler shop are very well suited for their new uses. Both of them have overhead traveling cranes, the former being a 30-ton girder crane, 59 ft. in length, serving half the width of the shop. There are two of these cranes in this shop of the rope drive type, but it is planned to replace them with electric driven cranes on the same runway.

All engineering work of this plant, including the design and construction of the buildings, has been in charge of Westinghouse, Church, Kerr & Co., 10 Bridge St., New York. The work has been under the direct supervision of Mr. F. H. Clark, Gen. S. M. P., and Thomas Roope, S. M. P., of the lines east of the Missouri River, and Willard Doud, shop engineer of the Burlington Lines.

COMPARATIVE TEST OF FOUR-CYLINDER BALANCED SIMPLE LOCOMOTIVE WITH SUPERHEATER

CHICAGO, ROCK ISLAND AND PACIFIC RAILWAY.

On page 467 of the December, 1909, issue of this journal appeared a very fully illustrated description of a 4-cylinder balanced simple locomotive of the Atlantic type, which was equipped with a Cole high degree superheater with side headers, of which two were built by the American Locomotive Company for the Chicago, Rock Island & Pacific Railway. These are the only examples of 4-cylinder simple locomotives with superheater that are in service in this country, although the same type has been in successful use abroad for a number of years.

Upon delivery, these two engines were put into service on the Illinois Division, between Chicago and Rock Island, a distance of 181.1 miles, and were used for hauling the fastest and most important passenger trains on that division. Other power also in use on the same division includes 4-cylinder balanced compound non-superheater Atlantic type engines built by the Baldwin Locomotive Works in 1905* and 2-cylinder single expansion locomotives of the same type, some of which have superheaters and others are non-superheater.† These locomotives were built by the American Locomotive Company.

Full advantage has been taken by the motive power department of that road to avail itself of the excellent opportunity of determining the relative value of the various designs of the same type of locomotive in the same service and during two weeks early in 1910 a series of comparative tests were made to determine the relative coal consumption and other factors of the different locomotives. The ones chosen for test were No. 1016, a 2-cylinder, single expansion, non-superheater engine; No. 1045, a 4-cylinder, Baldwin balanced compound, and No. 1041, a 4-cylinder balanced simple with superheater. These tests were made with regular trains, Nos. 7 and 8, between Chicago and Rock Island, and in the table below are shown the average result of six trips with each locomotive, three in either direction. The trains on every trip, with one exception, consisted of seven cars and the tonnage hauled was approximately the same in all the trials.

Inasmuch as the tests were conducted in very severe winter weather, the results obtained represented the performance of each locomotive under adverse conditions and therefore bring out more clearly the relative efficiency of the three classes as concerns fuel consumption.

The line from Chicago to Rock Island is practically level, all grades are short, the maximum grade being but 40 ft. to the mile. None of the curves are sharp, the worst one being 4 degs. 30 min.

A study of the results in the table will show that the balanced simple was decidedly more economical on both coal and water, and also that the balanced compound was more economical than the simple in coal and about the same on water consumption.

Of course, while coal and water economy are of great importance, the total efficiency of a locomotive must also include its cost of maintenance, and on this feature Bulletin No. 1007, issued by the American Locomotive Company, to whom we are indebted for this data, states that all three of these locomotives required almost exactly the same expense per engine mile for running repairs and that the saving of a balanced simple on coal and water is a net saving which is not offset by a greater expense of up-keep.

Locomotive No.	1016	1045	1041
Type	4-4-2	4-4-2	4-4-2
	Simple	Bal. Comp.	Bal. Simple
Total weight, lbs.	180,000	199,400	202,000
Weight on drivers, lbs.	102,000	105,540	116,000
Cylinders, diam. and stroke	21 x 26	15 & 25 x 26	17½ & 17½x26
Diameter drivers, in.	73	73	73
Steam pressure, lbs.	185	210	170
Tractive effort, lbs.	24,700	22,500	29,600
Total heating surface, sq. ft.	2,825.5	3,209	2,715
Number and size of flues	320—2	273—2¼	206—2
			24—5¼
Length of flues, ft. and in.	16-0	18-10	18-0
Flue heating surface, sq. ft.	2,667	3,015	2,551
Grate area, sq. ft.	44.86	50.4	42.8
Mileage since No. 1 or 2 repairs	24,623	34,324	12,680
TIME AND TONNAGE.			
Distance between terminals, miles	181.1	181.1	181.1
Average total time, hrs. and min.	5-6	5-7	5-58¼
Avg, running time, hrs., min. and sec.	4-32-26	4-46-36	4-34-13
Number of stops, average	6.33	7.15	14.6
Miles per hr (based on running time)	39.96	37.98	39.63
Number of cars	7	7.165	7
Weight behind drawbar, tons	401.24	406.47	404.05
WATER CONSUMPTION.			
Avg. temperature of feed water, degs. F.	42.3	42.18	42.16
Average steam pressure, lbs.	177.3	195.4	170.5
Weight water fed to boiler (lbs. per hr.)	22,120	22,324	16,650
Equivalent evaporation per hr., lbs.	27,100	27,350	20,400
Equiv. evap. per sq. ft. H. S. per hr., lbs.	9.6	8.53	7.42
Equivalent evaporation per ton mile, lbs.	1.907	1.911	1.67
Equivalent evaporation per lb. coal, lbs.	6.65	7.47	7.00
Equiv. evaporation per lb. dry coal, lbs.	7.07	7.77	7.47
COAL CONSUMPTION.			
Total weight of coal used, lbs.	20,852	18,832	17,466
Per cent. moisture in coal	5.95	3.91	6.28
Per cent. combustible in coal	84.47	84.36	83.81
Average coal per ton mile, lbs.	.2868	.2557	.2385
Average dry coal per ton mile	.2696	.2456	.2236
Average combustible per ton mile	.2422	.2157	.1999

NOTE.—Tests made during severe weather with range of temperature from 2.5 to 36.5 degrees.

SUCCESSFUL SALESMANSHIP means correct theory put into successful practice. It means the welding of self-reliance to up-to-date co-operative methods; it means the conversion of capacity into ability; it means facing with courage life's conditions as they are, and adapting one's self advantageously to such conditions. It means the proper adjustment of self into the machinery of commerce and human affairs. It means adaptability, resourcefulness, courage, patience, fortitude, quick perception, optimism and enthusiasm. It means, in its higher sense, skillful and harmonious execution upon the keyboard of human nature. The profession is dignified enough and its highest exactions are universal enough to challenge the admiration, interest and genius of the greatest intellects.—*T. H. Bailey Whipple in the Electric Journal.*

TELEPHONE DISPATCHING ON THE LOUISVILLE & NASHVILLE RY.—The Louisville & Nashville has ordered a complete equipment of Western Electric selectors and telephones for train dispatching on the Cumberland Valley and Kentucky divisions, from Cincinnati to Norton, 304 miles. There will be six circuits, four train wires and two message circuits, with a total of 162 stations. The message wire circuits to be used for general railway business extend from Paris to Cincinnati, from Cincinnati to Corbin, and from Corbin to Norton. The Louisville & Nashville already has Western Electric train dispatching equipment between New Orleans and Mobile, 140 miles.

DEPARTMENT OF AGRICULTURE reports imply that last summer's forest fires either burned or killed between one and two per cent. of the total stand of national forest timber. The total amount of timber killed or destroyed in Montana and Northern Idaho was over six billion board feet, and the area burned over is put at over one and one-quarter million acres.

* For full dimensions and general description, see AMERICAN ENGINEER, November, 1905, p. 416.

† For full dimensions and general description, see AMERICAN ENGINEER, Sept., 1905, p. 329.